NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

MODERNIZATION THROUGH SPARES: AN ANALYSIS OF IMPLEMENTATION AT THE U.S. ARMY AVIATION AND MISSILE COMMAND

by

Todd C. Kros

September 1999

Thesis Advisor: Brad Naegle
Associate Advisor: Keebom Kang

Approved for public release; distribution is unlimited.

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	September 1999	Master's Thesis

4. TITLE AND SUBTITLE
MODERNIZATION THROUGH SPARES: AN ANALYSIS OF IMPLEMENTATION AT THE U.S. ARMY AVIATION AND MISSILE COMMAND

5. FUNDING NUMBERS

6. AUTHOR(S)
Kros, Todd C.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Postgraduate School
Monterey, CA 93943-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(maximum 200 words)*

Modernization of legacy systems is one of the greatest challenges facing the U.S. Army today. In 1997, the Army spent $6 billion on spare and repair parts, exceeding the amount spent on new procurements. Yet, these spares, purchased based on the original design specifications, only served to maintain legacy systems, not improve them. The Modernization Through Spares (MTS) strategy seeks to leverage spares funds to achieve incremental modernization of legacy systems through the attrition of existing parts. Instead of buying the same old parts, MTS advocates the purchase of upgraded, or modernized, parts.

This thesis is undertaken to analyze and document the Army's MTS policies and guidance, and to evaluate implementation at the Aviation and Missile Command (AMCOM). Case study documentation presents various approaches being followed in three programs implementing MTS. A principal finding of this research is that while MTS is a revolutionary approach to modernizing legacy systems while reducing life cycle costs, it faces a number of implementation challenges. Key among these challenges are funding, incentives, and the conceptual approach to MTS. This thesis concludes with recommendations for fundamental changes to materially increase the benefits and motivate the use of MTS.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Modernization, Modernization Through Spares, MTS, Spares, Life Cycle Cost Reduction	101
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18, 298-102

Approved for public release; distribution is unlimited.

MODERNIZATION THROUGH SPARES: AN ANALYSIS OF IMPLEMENTATION AT THE U.S. ARMY AVIATION AND MISSILE COMMAND

Todd C. Kros
Captain, United States Army
B.A., Rice University, 1989

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
September 1999

Author: _____
Todd C. Kros

Approved by: _____
Brad Naegle, Thesis Advisor

_____
Keebom Kang, Associate Advisor

_____
Reuben T. Harris, Chairman
Department of Systems Management

ABSTRACT

Modernization of legacy systems is one of the greatest challenges facing the U.S. Army today. In 1997, the Army spent $6 billion on spare and repair parts, exceeding the amount spent on new procurements. Yet, these spares, purchased based on the original design specifications, only served to maintain legacy systems, not improve them. The Modernization Through Spares (MTS) strategy seeks to leverage spares funds to achieve incremental modernization of legacy systems through the attrition of existing parts. Instead of buying the same old parts, MTS advocates the purchase of upgraded, or modernized, parts.

This thesis is undertaken to analyze and document the Army's MTS policies and guidance, and to evaluate implementation at the Aviation and Missile Command (AMCOM). Case study documentation presents various approaches being followed in three programs implementing MTS. A principal finding of this research is that while MTS is a revolutionary approach to modernizing legacy systems while reducing life cycle costs, it faces a number of implementation challenges. Key among these challenges are funding, incentives, and the conceptual approach to MTS. This thesis concludes with recommendations for fundamental changes to materially increase the benefits and motivate the use of MTS.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. INTRODUCTION

> Modernization remains critical to the future of the United States Army. Although procurement dollars are not projected to increase for several years, we continue to develop new systems by leveraging and adapting technology from the private sector. Improvements to our existing systems are the best way to achieve the greatest returns for scarce resources and to leverage technology to the extent possible. – Togo West Jr., Secretary of the Army [Ref. 1, p. 3-1]

A. PURPOSE

The purpose of this thesis is to analyze the Modernization Through Spares (MTS) initiative and propose implementation improvements and incentives to support the MTS strategy. This research focuses on the application of MTS policy and guidance on three programs at the Aviation and Missile Command (AMCOM): Patriot, Apache, and Comanche. This analysis identifies life-cycle cost benefits, logistical system impacts, Program Management responsibilities, metrics and impacts, funding issues, incentives, and implementation lessons learned associated with the MTS approach. The objective of this thesis is to generalize from these lessons learned in order to benefit future programs applying the MTS strategy to their systems.

B. BACKGROUND

Modernization of legacy systems is one of the greatest challenges facing the U.S. Army today. Both Force XXI and Army After Next (AAN) leverage the uses of modern technology to achieve land force dominance. Historically, the Army has met this challenge through the procurement of new systems and major block upgrades to legacy systems.

An argument can easily be made that today's readiness is reflected in the operations and maintenance budget, while tomorrow's readiness is forecast in the

procurement budget. Traditionally, the procurement budget drove force modernization and kept the Army's equipment technologically advanced. The modernization effort was achieved through either the purchase of new advanced weapons systems, or the significant upgrade of legacy systems.

Over the past 15 years, the Army's budget has decreased by 40%, from a high of $110.8 billion in 1985, to $67.3 billion projected in 2000. More significantly, the procurement budget has decreased by 62%, from nearly $25.5 billion to $9.7 billion during the same period. This 62% decline in procurement has occurred while the operations and maintenance budget has decreased only 28%. [Ref. 2] When factored with the decrease in personnel end strength, this actually represents an increased operational tempo for the remaining systems. The decreasing Army budget and increased operational tempo have accelerated the aging of Army equipment and have forced the Army to shift procurement dollars to fund current operations and maintenance accounts.

Consequently, the Army is investing an ever-decreasing portion of the budget on modernization, with potentially adverse effects in the future. The Army can no longer afford to modernize just through new acquisitions and significant upgrades of legacy systems. The critical challenge for the Army becomes balancing current readiness requirements with future modernization goals to meet Force XXI and AAN technological objectives.

One way to meet this challenge is to reduce the cost of operating the existing force structure to free funds for new procurements. This option is reflected in the increased emphasis on the reduction of system life-cycle costs. Dr Kaminski, former Under Secretary of Defense for Acquisition and Technology, stated,

> ...As we purchase new and modified systems, we will stress reduction of overall life-cycle cost. To the extent DoD maintains systems longer, we must increase focus on reducing the cost of ownership for the remaining service life of our systems. [Ref. 1, p. 2-3]

MTS is one initiative focused on reducing the cost of ownership of legacy systems by embracing a radical philosophical change: instead of buying the same old spare parts, buy upgraded spare parts. It uses spares funds, not procurement dollars, to both maintain and modernize legacy equipment. One formal description of MTS states:

> MTS is a spares acquisition strategy applied throughout the material acquisition life-cycle to reduce sustainment cost. It is based on technology insertion and use of commercial products, processes, and practices to extend a system's useful life. [Ref. 3]

It seeks to improve on an end-items spare parts through the process of attrition. It takes advantage of performance-based specifications for spares to allow for greater design and manufacturing flexibility to exploit advanced commercial technologies.

In 1997, the Army spent $6 billion on spare and repair parts, actually exceeding the amount spent on new procurements [Ref. 4]. Yet, these spares were generally purchased based on the original design specifications. Under this process the same spare part – meaning identical detail specifications, capability, reliability, and cost – was continually purchased and used as needed. The legacy system was kept operational, but no improvements of any type were realized. In effect, the Army was spending huge sums of money just to maintain a capability, without improving the system.

MTS aims to end this practice by leveraging spares funds to achieve incremental modernization of legacy systems through the attrition of existing spare parts. Through the introduction of these modernized spare parts, the Army seeks not only to maintain its legacy systems, but also to improve and modernize them. The improvements may be realized through any combination of improved reliability, reduced cost, and increased

capability. Whatever the actual improvements resulting from a particular modernized spare, MTS seeks to reduce total system life-cycle costs.

A simple example of a MTS success involves the Aviator Night Vision Goggles (NVG's). The old night vision goggle tubes, while superior to any other existing system, still had inadequate performance. Additionally, the reliability of the tubes was poor. Through a MTS effort using performance-based specifications, the reliability of the tubes was increased by 33% and unit procurement cost decreased by 62%. Modernized spare tubes were inserted into the system as the NVG's were rotated in for their annual scheduled maintenance or as unscheduled tube failures occurred. In addition to improved reliability and decreased cost, performance was enhanced. The light sensitivity of the tubes was enhanced and the field of view was increased. [Ref. 3]

MTS is a critical element of controlling costs in Army acquisition now, and in the future. The Honorable Paul Hoeper, the Assistant Secretary of the Army for Acquisition, Logistics, and Technology, and the Army Acquisition Executive describes MTS as weapons systems brain transplants. He notes that not all systems may lend themselves to MTS, but suggests,

> ...MTS is one of our key methods for keeping the force modern and keeping our current vehicles interoperable with the vehicles we plan to field between now and the Army After Next. We need to do more of it. [Ref. 5]

C. RESEARCH QUESTIONS

1. Primary Research Question:

What improvements can be made to the Modernization Through Spares initiative in order to maximize its potential benefits in future applications and what measures can be taken to incentivize the use of MTS?

2. **Secondary Research Questions:**

a. What is the MTS policy and what is the implementation process?

b. What benefits and challenges have selected AMCOM acquisition programs realized through the implementation of the MTS strategy?

c. What impact is MTS having on program life-cycle costs, schedule, performance, and risk?

d. What are the responsibilities of a Program Manager to the MTS initiative?

e. What is the impact of MTS on the logistics system?

f. What is the relationship of MTS to other cost reduction acquisition reform initiatives? How can MTS leverage these other initiatives, or be leveraged by them?

D. SCOPE

The scope of this thesis will include analysis of the MTS implementation at three Aviation and Missile Command programs: Patriot, Apache, and Comanche. These programs were selected to represent developmental systems, legacy systems, and test support equipment. It will examine the life-cycle cost benefits, logistical system impacts, Program Management responsibilities, funding issues, and limitations associated with implementation of an MTS strategy. It will review the relationships of MTS to other acquisition reforms aimed at the reduction of life-cycle costs. The thesis will conclude with recommendations for improvements and lessons learned from the selected AMCOM programs during implementation of MTS.

This thesis does not address the mechanics of executing MTS in detail, except as needed to support the analysis of the three programs. The mechanics of MTS are discussed in detail in many of the references found at the end of this thesis.

E. METHODOLOGY

The objective of this thesis is to analyze the implementation of the MTS strategy on three programs at AMCOM, document applicable lessons learned, and determine improvements to the MTS approach. To accomplish this, descriptions of both MTS and the three AMCOM programs are presented to provide a better understanding of the MTS strategy and the programs involved. The methodology used in this phase of the thesis research consisted of the following steps:

1. A thorough review of books, magazines articles, web sites, speeches, briefings, and conferences describing MTS.
2. A thorough review of relevant acquisition policies and regulations, to include draft policies and regulations.
3. A thorough review of the existing spare parts procurement procedures.
4. Review and analysis of AMCOM select acquisition program MTS data.
5. Interviews with AMCOM acquisition personnel concerning policy, actual program MTS results, impressions of the benefits and challenges in implementing MTS, and how to best make MTS a long-term, viable strategy.
6. Interviews with MTS Overarching Integrated Product Team (OIPT) members and program personnel involved in development of their MTS initiatives.

Following the collection of the background information, an analysis of the MTS implementation at the three AMCOM programs was conducted. First, lessons learned to facilitate successful implementation of an MTS strategy in existing and future acquisition programs were documented. Then proposed improvements to the existing MTS initiative were developed.

Research travel was conducted to the MTS Acquisition and Logistics Conference held from 16 to 18 November 1998 in Washington, D.C. Speeches, presentations, papers, and interviews were collected at this event.

F. ORGANIZATION

Chapter II provides an overview of the MTS strategy. It begins by describing what MTS is, and why it is needed. It then discusses the need to modernize and outlines the Army Modernization Plan. The chapter then focuses on outlining Acquisition Reform initiatives related to the reduction of system life cycle costs and MTS. It then returns to the implementation of MTS and metrics. The chapter continues with ten excellent examples of MTS initiatives, provided to give an understanding of the wide ranging scope of benefits provided under MTS. Finally, the chapter concludes with a look at the recognized challenges facing implementation of MTS.

Chapter III introduces the three AMCOM programs being evaluated: Patriot, Apache, and Comanche. Weapons system description and mission, MTS strategy, and actual MTS initiatives (if applicable) for each program are discussed. Additionally, the draft AMCOM MTS strategy is discussed.

Chapter IV analyzes the MTS approach being implemented in these three programs. It examines the example MTS initiatives previously introduced. It focuses on implementation policies, oversight, impacts on cost, schedule, performance and risk, funding, metrics, incentives, realized benefits, challenges, and integration with other life-cycle cost reduction initiatives. It concludes with a generalized lessons learned from the applications of MTS within these three programs so that they will be useful to applications of MTS in other programs.

Chapter V is the final chapter. Conclusions and recommendations are provided. Finally, areas for further research within the scope of MTS and reduction of life-cycle costs are provided.

G. BENEFITS

This research is the first at the Naval Postgraduate School addressing the MTS approach. It will provide a thorough understanding of the MTS approach, its relationship to other life-cycle cost reduction programs, and provide acquisition programs with the necessary information to improve the implementation and execution of their MTS strategy. The result will be reduced near-term life-cycle costs for legacy systems, and reduced future costs for developmental systems. The generalized lessons learned will provide programs more insight into MTS to maximize their cost savings and program effectiveness.

II. MODERNIZATION THROUGH SPARES

> The Army spends several billions of dollars annually on the procurement of spare parts. In most cases, these procurements are repetitive, build-to-print acquisitions. They result in the replenishment of current part numbers, but with little improvement in the part itself or the higher level assembly or sub-system. – Gil Decker, ASA RD&A [Ref. 6, p. 22]

A. INTRODUCTION

This chapter provides an overview of the MTS strategy. It begins by describing what MTS is, and why it is needed. It then discusses the need to modernize and the Army Modernization Plan. The chapter then focuses on outlining Acquisition Reform initiatives related to the reduction of system life cycle costs and MTS. It then returns to the implementation of MTS and metrics. The chapter continues with ten excellent examples of MTS initiatives, provided to give an understanding of the wide ranging scope of benefits provided under MTS. Finally, the chapter concludes with a look at the recognized challenges facing implementation of MTS.

B. MODERNIZATION THROUGH SPARES

The Army Materiel Command (AMC) MTS Homepage defines MTS as, "...a spares/component improvement strategy applied throughout the Acquisition Life Cycle and based on technology insertion to enhance systems and extend useful life while reducing costs." [Ref. 3]

1. What is MTS?

MTS is a relatively new initiative employed to reduce rising legacy system Operations and Sustainment (O&S) costs. It leverages normal Operations and Maintenance (O&M) funds to insert improved spare parts into legacy systems. This

contrasts with the previous system, where improved spares must be developed using Research & Development funds, and purchased using Procurement dollars.

MTS strives to end the practice described by the Honorable Gil Decker, former Assistant Secretary of the Army for Research, Development and Acquisition (ASA RD&A), at the beginning of this chapter – spending huge sums of money to maintain a system, but without any improvement to the system. It attempts to achieve this by using spares funds from O&M budgets to achieve incremental modernization of legacy systems through the attrition of existing spare parts. In effect, as spare parts are replaced with improved spares, MTS ensures a "continuous technology refreshment" [Ref. 3], or "brain transplant" [Ref. 5, p. 3], to not only maintain, but modernize the legacy system. This process can reduce spare parts O&S costs and extend the useful life of a legacy system. [Ref. 3]

MTS is an acquisition reform initiative that seeks to reduce the cost of operating the existing force structure and simultaneously modernize legacy systems. It can be considered a significant extension of military specification (MILSPEC) reform, with its focus on performance specifications rather than detail specifications. MTS employs the principles of MILSPEC Reform – specification of form, fit, function, and interface – to provide the supplier with greater design and manufacturing flexibility [Ref. 7]. This leverage of commercial technologies in spares acquisition, unique among the U.S. military services, should result in improved spares reliability, lower costs, and/or enhanced performance.

a. MTS Approach

The MTS approach suggested on the AMC MTS Homepage consists of five essential elements, shown in Figure 1.

The heart of the MTS process is in the Integrated Product Team (IPT). The IPT, composed of all relevant functional disciplines, is the responsible body for implementing MTS within their respective programs.

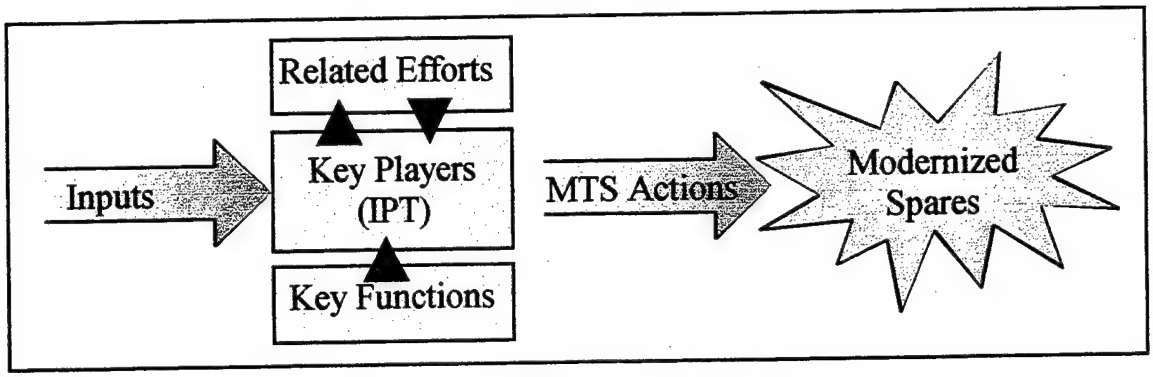

Figure 1: MTS Approach [Ref. 3]

Following selection of MTS candidates, the IPT receives inputs to "determine feasibility, cost effectiveness, and practicality of modernization." [Ref. 6, p. 24] This input will consist of market analysis, technological advancements, cost benefit analysis, producibility studies, and analysis of commercial alternatives.

Key functions are the "policies and principles which influence decisions regarding implementation." [Ref. 3] These functions include acquisition strategy and plan, test and evaluation, and supportability. Integrated with an IPT members experience, skills, and background, these functions provide for a basis for program managers to structure their programs.

Related acquisition initiatives may contribute immeasurably to the success of an MTS initiative. They may be employed independently, or many initiatives may be

employed simultaneously. Many of these initiatives are introduced in Section D of this chapter.

Outputs of an MTS effort depend on the acquisition stage that a program is currently in: development (Pre-Milestone III) or production/sustainment (Post-Milestone III). While the MTS program addresses both, the real focus of MTS is on immediate cost savings (three to five years), or post-MS III. A brief description of both procedures and outputs is provided in Section E of this chapter.

b. Tenets of MTS

The MTS strategy focuses on three tenets. [Ref. 3]

- Insertion of modern technology into legacy systems, without expenditure of Research and Development funds.
- Implementation of Acquisition Reform flexibilities.
- Teaming with industry to develop new types of relationships.

This last tenet addresses a paradox generated by MTS. Improvements in reliability and reduction of costs negatively impact industry on sales of spare parts in the long run. Therefore, this third tenet of MTS acknowledges the need to establish innovative relationships with industry.

c. End-state Goals

The goal of MTS is to insert advanced technologies into legacy systems to improve reliability and reduce costs. These goals are attained, in part, by applying performance specifications on spare parts, dual-use technologies, commercial products, and employment of open systems architecture. Equally as important, the modernization is achieved using O&M funds, freeing critical R&D and procurement funds for new system development and acquisition.

The AMC MTS Homepage notes three specific goals for MTS [Ref. 3]:

- Update spares currently being acquired with modern technology where the cost benefit is greatest.
- Leverage spares procurement dollars to update within current funding levels.
- Capture savings in spares acquisition and support cost for reinvestment in Army force modernization.

2. Policy, Guidance, and Training

MTS as a program is quite new. Policy and guidance are still in an embryonic stage. Fortunately, many agencies, both military and commercial, are attempting to document processes, procedures, and training to develop and spread MTS.

a. Origins of MTS

MTS as a concept is not new. Examples of MTS dating to the 1960's are provided in MTS training resources. The F-4 Phantom replaced a control transformer at one-third the price of the original part with improved performance and reliability. This transition was accomplished as a value engineering proposal submitted by industry, yet followed what we would now consider MTS procedures. [Ref. 8]

In July 1995, the Defense Systems Management College published Modernization in Lean Times: Modifications and Upgrades. In an attempt to differentiate the multiple types of modernization, the authors described component modernization. They stated that component modernization was,

> ...a process by which a part, sub-assembly, assembly or accessory is replaced by an improved item when the old version fails. Form, fit, function and support requirements of the component are changed. [Ref. 1, p. 3-5]

The first reference to MTS in an official document occurred in a January 1996 memorandum. The memorandum, from General Leon Salomon, a former

Commanding General at AMC, and the Honorable Gil Decker, identified the failings of the repetitive, build-to-print spares acquisition process. They then noted the successes possible by applying performance specifications to spare parts, as well as newer designs. Many of the existing MTS implementation procedures are outlined, in rough form, in this memorandum. Through the remainder of 1996 and through 1997, a number of high-level memoranda circulated further developing and shaping MTS.

b. MTS OIPT (Overarching Integrated Product Team)

In June 1997, after an exploratory conference on MTS at Missile Command, General Wilson, the new Commanding General of AMC, directed the formation of an MTS Overarching Integrated Product Team (OIPT). The OIPT, chartered under the ASA RD&A, has a mandate to "identify approaches to leverage Operations and Support spares procurement to achieve Army modernization objectives." [Ref. 3] Each major subordinate command under AMC, as well as all Program Executive Offices, was directed to provide members for this team. Their goal was to formalize the Army MTS process, then advise, assist, and monitor implementation of MTS.

The OIPT product is the MTS Homepage. It is a living and changing document, continuously updated to reflect process experiences and recommended improvements. It is a definitive source on the implementation of MTS. All of the details of executing an MTS strategy, intentionally not discussed in this thesis, can be found in detail on the AMC MTS Homepage.

Finally, in January 1998, a memorandum from General Wilson, at AMC, and the Dr. Kenneth Oscar, the acting ASA RD&A, formalized MTS as policy. Among the directives, all programs, both in development or production/support phases, must

develop MTS strategies and post them on the Internet. Furthermore, programs in development should include their MTS strategy in their Acquisition Strategy Report and reflect it in their Integrated Logistics Support Plan. Programs already in production should select candidates for MTS and apply the MTS initiatives. [Ref. 3]

c. Other Training Resources

Many additional resources now exist to support the development and implementation of an MTS strategy. For example, BRTRC Institute has developed a number of MTS training courses, available both on-line and through Acquisition Reform Workshops. In fact, BRTRC has been heavily involved in the actual refinement of the MTS implementation process, as can been seen on the AMC MTS Homepage.

3. Why Do We Need MTS?

General Wilson, Commanding General of AMC, stated:

> We must achieve a modern and superior war fighting capability by inserting current technologies into our weapon systems. With declining budgets, we cannot achieve superiority solely on development and procurement of weapon systems. [Ref. 3]

MTS is needed for a variety of reasons. Declining defense budgets have severely restricted R&D and procurement dollars. The procurement budget alone has decreased nearly 62%, from $25.5 billion in 1985 to a projected $9.7 billion in 2000. [Ref. 2]

Since product improvements previously were funded with procurement dollars, this dramatically reduced funds available for new procurements. In fact in 1997, the Army actually spent more on spare parts than on new procurements. [Ref. 4]

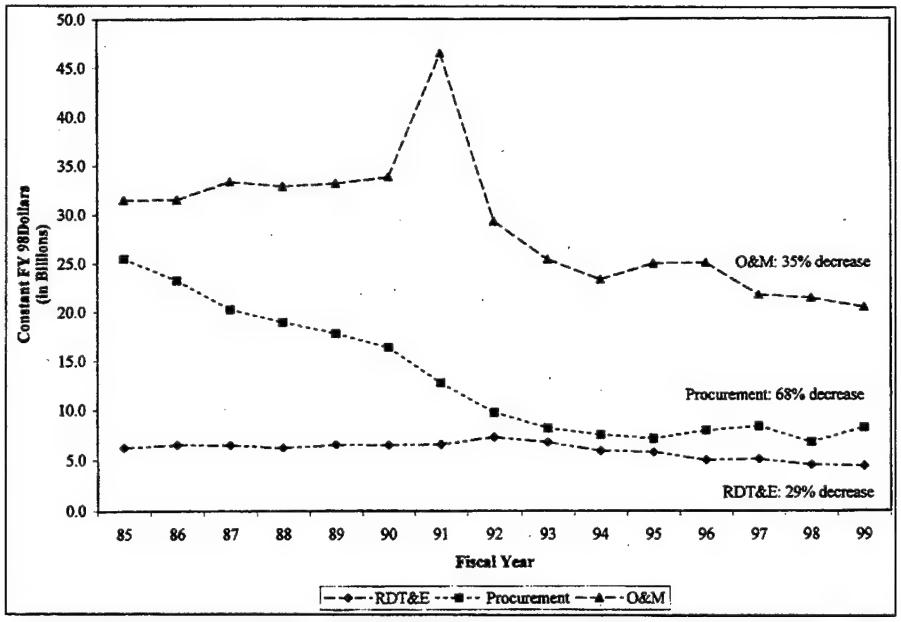

Figure 2: Army Budget 1985 – 1999 [Ref. 2]

Over the same period, the Army has experienced a dramatic increase in the number of missions and a decrease in the number of divisions. This resulted in an accelerated aging of the available weapon systems. Both the increase in missions and accelerated aging of the equipment created a rapidly increasing cost of maintaining legacy systems. [Ref. 9, p. 32]

Also, the majority of costs associated with any system over the life-cycle of the system are concentrated in O&S. Much effort has been placed on reducing development and procurement costs, but O&S costs were often overlooked. Opinions vary, but conservative estimates place the average O&S cost of a system at approximately 60% to 65% of total life-cycle costs (LCC) [Ref. 10, p. 4]. As Figure 3 demonstrates, R&D and procurement dollars combined represent less than one-half of a system's total LCC.

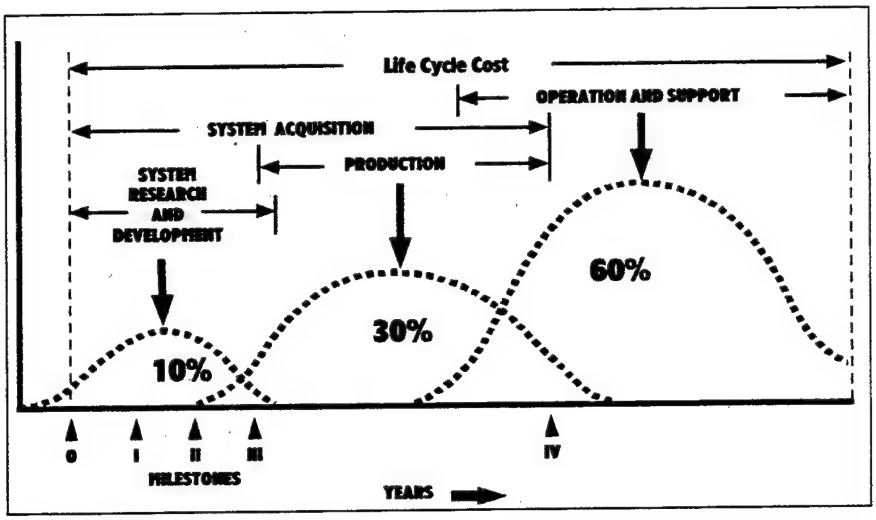

Figure 3: Typical Life-Cycle Cost Distribution [Ref. 24]

But now with the increased emphasis on program management responsibility for total LCC, PM focus is broadening from just R&D and procurement costs to include O&S cost management. [Ref. 11]

Last, the ambitious modernization goals of the Army require a significant amount of funding. In order to free funds to support the modernization plan discussed below, innovative methods must be employed to maximize use of existing funding. Existing equipment must be maintained and upgraded, where possible, to ensure a current capability, and to support a smooth integration with future equipment fielding.

C. ARMY MODERNIZATION

Former Secretary of the Army Togo West characterized the mission of the Army as, "to win our nation's wars and protect its vital interests." [Ref. 1, p. 3-1] Modernization of legacy systems to maintain land force dominance in order to accomplish those goals of winning and protecting is one of the greatest on-going challenges the Army faces.

1. Why Modernize?

The U.S. Army 1998 Modernization Plan, published by the Office of the Deputy Chief of Staff for Operations and Plans, states, "The overarching reason to modernize is to maintain greater combat capability than a potential enemy's." [Ref. 12, p. 3] The Army, as America's force of decision, must be able to deter evolving threats, and if necessary, fight and win. Modernization is the path to achieve those goals.

2. Modernization Environment

a. Threat-based Modernization

This requirement to deter, or fight and win, is even more difficult to prepare for given the rapidly changing environment facing our armed forces. The bipolar geopolitical environment of the post-World War II era was relatively stable and the threat was well-defined. Therefore, modernization was threat-based, or focused on a balanced modernization of a few critical systems to meet the challenges imposed by the single threat – the Soviet Union. [Ref. 12]

Since the end of the Cold War, however, the modernization environment in which the Army operates has changed in three basic ways. [Ref. 1, p. 3-2]

1. Methods of developing and producing weapon systems changed.
2. Plans for land force requirements proved inaccurate.
3. Reductions in funding, especially in areas of research, development, and procurement, were greater than expected.

b. Capabilities and Knowledge-based Modernization

The end of the well-defined threat led to a change in the geo-political structure of the world. This, in turn, resulted in numerous and unpredictable threats, largely through the proliferation of sophisticated weapons. It became increasingly

difficult to focus a modernization effort on any specific requirement. In short, the modernization focus shifted from "remaining inside the development cycle of the former Soviet Union, to a program of continuous modernization." [Ref. 1, p. 3-2]

This style of modernization strategy came to be known as capabilities and knowledge based modernization. Instead of a program of balanced modernization based on a few critical systems, the Army embarked on a program of balanced modernization based on five objectives. [Ref. 12, p. 3] These five balanced modernization objectives – dominate maneuver, project and sustain, protect the force, win the information war, and precision strike – would provide the capabilities required to achieve land force dominance.

c. Full Spectrum Dominance

Changes from various sources made the five balanced modernization objectives no longer appropriate. The overarching development driving this change was the formulation of Joint Vision 2010 (JV 2010) by the Department of Defense (DoD). JV 2010 "provided the conceptual template for achieving new levels of effectiveness in joint warfighting." [Ref. 12, p. 4] This change in philosophy shifted the focus from land force dominance to full spectrum dominance, fully embracing the concept of joint warfare.

At about the same time as the release of JV 2010, the Army was conducting the Army Warfighting Experiments (AWE). These experiments were conducted as part of the Force XXI process. Force XXI is the Army's first information age Army, seeking to forge an integrated mix of old and new equipment [Ref. 12]. The results of AWE provided the Army with new lessons on how to integrate advanced

technologies, especially information technologies, with existing equipment to leverage their capabilities.

Additionally, following the release of JV 2010, the Army published Army Vision 2010 (AV 2010). The operational environment and missions described in AV 2010 became the "blueprint for the Army's performance contribution" to the concepts of JV 2010. [Ref. 12, p. 4] All Army modernization efforts should follow this new template.

The last circumstance leading to a departure from the capabilities and knowledge based modernization strategy, and one of critical importance to this research, was the increasing resource shortage. The continually changing environment, having shifted from a bipolar world to a spread-spectrum threat environment, has forced the Army to respond to a variety of small-scale contingencies and asymmetric threats. Yet, simultaneously, the Army has been faced with a decreasing Total Obligation Authority, or budget. The increased operational tempo, combined with a decreasing budget, is having a serious impact on the Army force structure. The Army has recognized,

> ...a higher-than-programmed toll on the useful life of Army equipment, thus shortening potential life cycles and further increasing the need for recapitalization. Diversion of modernization funds (to fund operations) has resulted in slowing, stretching, or canceling key programs, accepting the inefficiencies of these actions, and deferring the capabilities these systems would provide. Today's modernization and investment strategy emphasizes reducing this migration from procurement accounts and providing procurement stability. [Ref. 12, p. 4]

3. Army Modernization Strategy

The Army Modernization Strategy to meet full spectrum dominance is comprised of three elements: vision, goals, and investments.

a. Modernization Vision

As part of the Joint Vision 2010 blueprint, the Army published Army Vision 2010. This became the Army's contribution to the JV 2010 concept. The vision defined the capabilities needed by the Army to achieve increased effectiveness in a joint environment and became the Army's modernization template. [Ref. 12] AV 2010 states:

> Enable Army Vision 2010 by equipping a capabilities-based Army to achieve full spectrum dominance in conducting prompt and sustained joint operations while protecting the essential elements of the science and technology and industrial bases. [Ref. 12, p. 6]

b. Modernization Goals

The Army strategy also outlines a series of modernization goals to be reached during the next decade. The five major goals are [Ref. 12]:

1. Digitize the Army
2. Maintain Combat Overmatch
3. Sustain Essential Research and Development and Focus Science and Technology to Leap-Ahead Technology for the Army After Next
4. Recapitalize the Force
5. Integrate the Active Component and the Reserve Component.

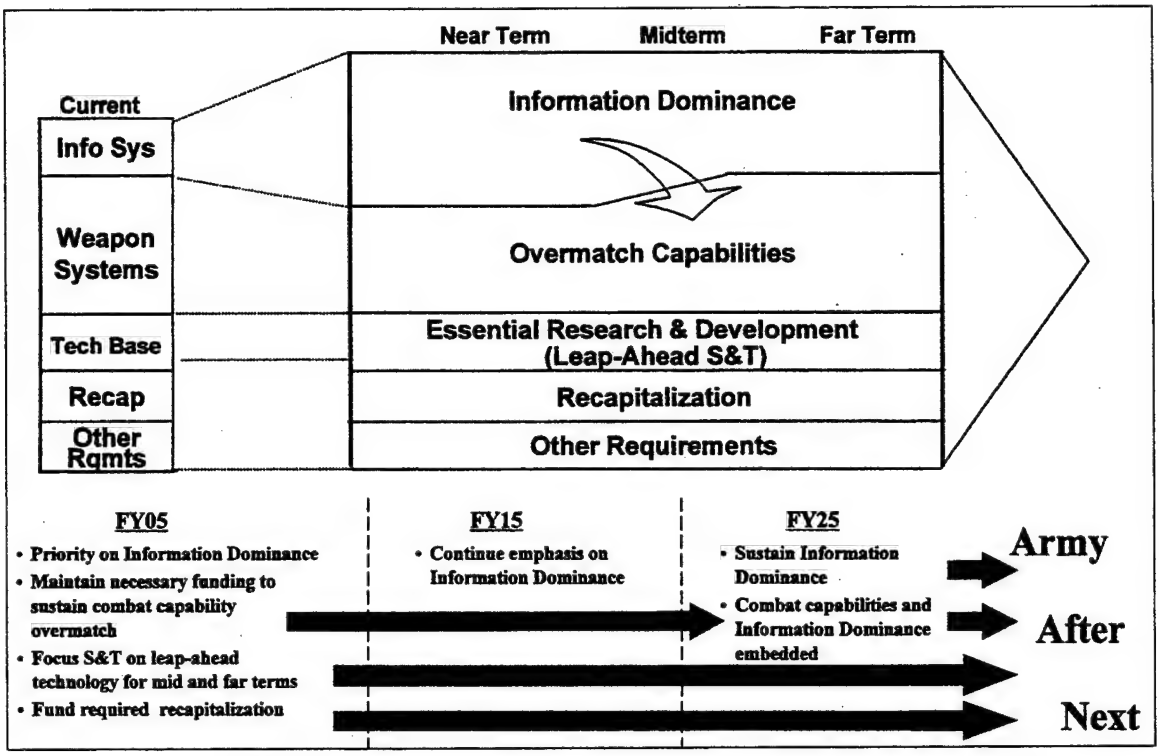

Figure 4: Army Investment Strategy [Fig. 50]

Of these five goals, recapitalization is central to this discussion. Recapitalization is the planned investment of funds into legacy systems to maintain, if not improve, their safe, reliable, usable, and effective operation through an increased life cycle. A recapitalization program is necessary to "guard against fleet obsolescence and the high costs associated with maintaining aging equipment." [Ref. 12, p. 10] Unfortunately, the recapitalization effort is often neglected. Consequently, at current production and fielding rates, many Army systems will be obsolescent and increasingly expensive to maintain.

In addition to not providing the soldiers with the most current and capable systems, "the Operating and Support (O&S) costs to maintain aging fleets drain precious dollars from procurement accounts." [Ref. 12, p. 10] Dr. Gansler, the Undersecretary of Defense for Acquisition and Technology, has referred to this phenomenon as the

procurement death-spiral. As more and more resources are needed to support increasing O&S costs and readiness, procurement and R&D accounts are stripped of their funds. These are "resources we should be applying to modernization of the traditional systems and development and deployment of the new systems." [Ref. 9, p. 32] Legacy systems then must remain in service, without significant modification, for longer periods, requiring more O&S funds. This is the death-spiral.

c. Modernization Investments

The modernization investments, as outlined in the U.S. Army 1998 Modernization Plan, are prioritized over time and linked directly to the operational environment envisioned in JV 2010. It is, in effect, an attempt to optimize each scarce dollar spent on modernization.

First, the investments are divided into three time frames: Near-Term, Mid-Term, and Far-Term. This allows for better focus and shifting of effort to best synchronize all modernization activities to meet JV 2010.

The Near-Term, Fiscal Year (FY) 1998-2003, focuses on information dominance. In this period, relevant goals are to minimize funding necessary to maintain current capabilities and to recapitalize essential aging systems. The intent is to free critical funding for use in science and technology research efforts to develop advanced leap-ahead technologies.

The Mid-Term, FY 2004-2010, focuses on continued information dominance plus the beginnings of the achievement of physical agility necessary for full-spectrum dominance. Relevant goals in the mid-term include the focusing of earlier basic research and applied research. The mid-term also calls for the Army to continue to reduce

the age of its fleet through recapitalization, technology insertion, new system acquisition, and aged systems retirements.

Last, the Far-Term, FY 2011-2020, achieves the goal of full-spectrum dominance. Relevant priorities include the provision for stable funding for procurement and research, and most notably, a plan to continue recapitalization. In effect, recapitalization will be informally institutionalized as a method for maintaining a greater combat capability than that of a potential enemy.

Second, the investments are "crosswalked to ensure linkage with each pattern of operation." [Ref. 12, p. 12] This provides assurance that each investment is within the framework for future modernization, and therefore provides a needed capability within full spectrum dominance.

4. Army Modernization Assessment

The Army Modernization Plan provides for a method of assessment of the capability to achieve full spectrum dominance within the framework of JV 2010. This method employs a GREEN, AMBER, and RED rating scale to identify the level of existing capability. GREEN indicates adequate capability and quantity, AMBER indicates limited capability and quantity, and RED indicates no capability, or insufficient capability. This rating scheme is applied to 15 different Army systems at the near, mid, and far terms as defined earlier. [Ref. 12]

In 1998, the Army rated its collective level of near-term modernization as AMBER. Most significantly, the Army believes that this rating will decrease to RED by the end of the mid-term, without sufficient infusion of resources for recapitalization of legacy equipment and acquisition of new systems. [Ref. 12] The near-term ratings for

Aviation and Air and Missile Defense, both studied in this thesis, are AMBER. The Undersecretary of the Army, Bernard Rostker, addressing the modernization status, noted that, "We have the programs, but we don't have the resources to procure new systems." [Ref. 13] He also felt that there was not enough funding to improve existing systems. As a result, he believes that there is insufficient funding to meet the mid and long-term goals of upgrading equipment and fielding a dominant force on the future battlefield. [Ref. 13]

D. ACQUISITION REFORM

Acquisition reform envisions, "An empowered professional acquisition workforce that continuously innovates and improves processes to get the latest and best technology, goods and services, on time and at the lowest cost for our soldiers." [Ref. 14, p. XX] Modern acquisition reform has its beginnings in the National Performance Review (NPR) led by Vice President Gore in 1993. In the NPR, the need to transform the way the government developed and acquired products and services was highlighted. Specifically, it directed that we streamline procurement, refocusing from rigid rules to guiding principles. [Ref. 15, p. 5] Eventually, the Department of Defense Directive (DoDD) 5000.1, Defense Acquisition, was updated to reflect this new approach.

1. Goal of Acquisition Reform

Acquisition reform began as a method to provide programs the opportunity to alter the traditional ways of doing business. The intent of the DoDD 5000.1 is to generate "an acquisition environment that makes DoD the smartest, most responsive buyer of the best goods and services that meet our warfighter's needs at the best dollar value over the life of the product." [Ref. 16, p. 1]

2. Themes of Acquisition Reform

Acquisition reform, as outlined in the DoDD 5000.1 Executive Summary, has six generally accepted themes. These are [Ref. 16]:

- Teamwork
- Tailoring
- Empowerment
- Cost as an Independent Variable (CAIV)
- Commercial Products
- Best Practices.

All of these themes are directly applicable to MTS. For the purposes of this thesis, both teamwork and best practices deserve further attention. Teamwork encourages the use of Integrated Product Teams (IPTs), composed of representatives from relevant functional disciplines working together to identify and resolve issues. There are three types of IPT's: overarching IPT's (OIPTs), working level IPTs (WIPTs), and program level IPTs. The OIPT focuses on strategic guidance, while the WIPTs identify and resolve specific program issues, and seek opportunities for acquisition reform. [Ref. 17] Cooperation and empowerment of these team members is essential for a successful program. Best practices encourage the use of sound commercial practices. Significant among these commercial best practices is performance specifications. [Ref. 16]

3. Specific Acquisition Reforms

There are many aspects of acquisition reform. There are also many programs designed to support the goals of acquisition reform and life cycle cost reduction. Figure 5 demonstrates the complex relationship between these programs and their funding.

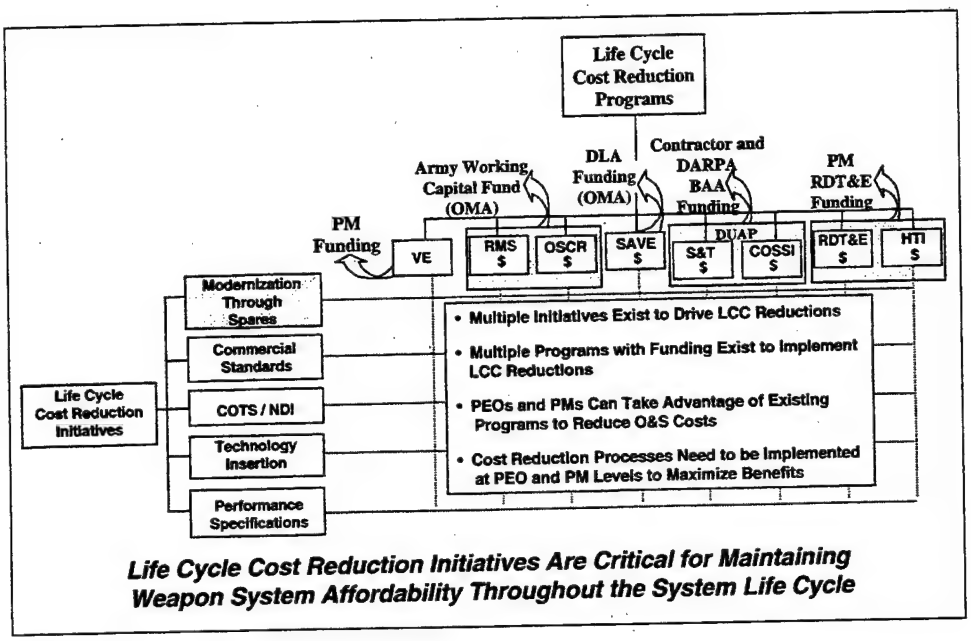

Figure 5: LCC Reduction Programs [Ref. 18]

What differentiates MTS from many of these other programs is that "...the MTS concept formalizes LCC reduction initiatives into a strategy to ensure cost reductions are a consideration in all programs and decisions throughout the system life-cycle." [Ref. 19, p. 35] The goal of cost reduction is now mechanistic in nature, not opportunistic. The complex nature of the many LCC reduction opportunities and funding programs is shown in Figure 5. Some of the more relevant initiatives are discussed following the diagram.

a. SMA-OSCR

The Supply Management, Army (SMA) Operating and Support Cost Reduction (OSCR) program provides funding from existing SMA AWCF authorizations to redesign high cost, high turnover items to reduce life cycle costs. Cost reductions may come from lowered acquisition costs, extending the item's useful life, or improving reliability, maintainability and supportability. SMA-OSCR is limited to programs requiring $100,000 or less. Approval must be granted by Headquarters AMC for any

higher dollar requirements. The size of the SMA-OSCR budget for Fiscal Year (FY) 97 was $21 million. Two noteworthy points about SMA-OSCR funds are [Ref. 20]:

- SMA-OSCR initiatives must not depend on additional non-programmed funding for implementation.
- SMA-OSCR can only be used to fund engineering analysis and redesign. The program cannot be used to purchase new or replacement items.

b. Performance-based Specifications

Performance-based specifications are a dramatic shift from the earlier method of acquisition – detailed military specifications (MIL SPECS). MIL SPECs dictated design, materials, and manufacturing processes. This hampered the commercial market from providing innovative solutions to problems. Through MIL SPEC Reform, MIL SPECs are no longer desired. It is important to note that Army Regulation 70-1, Army Acquisition Policy, states that, "Solicitations for all new programs...and spares, will state needs, to include reliability requirements, in terms of performance specifications." [Ref. 21, para. 5-13] In fact, the use of MIL SPECs requires a milestone decision authority waiver.

Performance specifications allow for a greater variety of alternative solutions and technologies, and place the responsibility for producing a working product on the contractor. The performance specification states requirements in terms of results – what it needs to do - and provides criteria for validation of performance. The real benefit in this process is the cost savings generated by permitting commercial contractors to integrate their own technologies and processes, often superior to the outdated MIL SPECs, into the development of a product. [Ref. 20]

c. Open Systems Architecture

Open Systems Architecture is a design that implements open, or standardized, specifications for interfaces. It allows insertion of standardized components across a wide range of systems with minimal modifications, and facilitates interoperability with other components and systems. An open system is characterized by well-defined, non-proprietary interfaces, the use of industry-wide recognized standards, and the provision for the expansion or upgrading of components with minimal impact to the remainder of the system. [Ref. 22]

d. Commercial Operations and Support Savings Initiative

Commercial Operations and Support Savings Initiative (COSSI) is a joint program to use commercial technologies to reduce O&S costs. COSSI will provide up to 75% of funding for modification and test and evaluation for legacy system upgrades. The contractor must front the remaining 25%, and receives sole source status for procurement. In FY 97, $97 million was spent funding COSSI programs, yielding an estimated $3 billion in savings. [Ref. 8]

e. Value Engineering

Value Engineering (VE) is a systematic analysis of the functions of a program, system, component, or part directed at improving performance, reliability, quality, safety, and LCC. The DoD VE program incentivizes both government and contractor workforces to submit ideas for potential improvements under the Value Engineering Proposal (VEP) or Value Engineering Change Proposal (VECP), respectively. [Ref. 20]

g. Technology Insertion

Technology Insertion is the upgrade and repair of spare parts using proven designs. Often these designs come from commercial off the shelf (COTS) technologies. The intent is to improve performance, cost, reliability, and maintainability of the system throughout its life-cycle. [Ref. 23]

Similar to technology insertion, yet different in a couple of critical ways is Horizontal Technology Integration (HTI). The goal of HTI is to apply leading edge technologies across multiple platforms to improve capability and maximize component commonality across the force. HTI attempts to break away from the traditional vertical stovepipe approach to system acquisition, instead opting to stress the horizontal sharing of technologies, reaping the associated developmental cost savings. [Ref. 21]

E. EXECUTION OF MTS

1. Implementation of MTS

The intent of this section is to provide a broad overview of the implementation of MTS. Greater detail can be obtained on the AMC MTS Homepage.

a. Program Manager Responsibilities

The spares acquisition management effort currently rests with national inventory control points (ICP). These ICP's, part of AMC, purchase and control spare parts. [Ref. 6, p. 23] But with the renewed emphasis on the Program Manager (PM) being focused not just on development and procurement costs, but on total LCC as well, the spares acquisition process becomes the PM's responsibility. [Ref. 11] Therefore, MTS is the PM's responsibility as well. In fact, the role the PM plays is pivotal, since MTS requires that the pre-existing "stovepipe approach to logistics be integrated with

engineering, contracting, and cost analysis within the IPT under the leadership of the PM." [Ref. 3] It takes the emphasis of the PM to break down these stovepipes and achieve a total LCC focus.

MTS is integrated into the acquisition life-cycle through the ILSP and the Acquisition Strategy. Therefore, it is fully integrated into the program management infrastructure. In this MTS environment, General Yakovac sees the PM with two primary tasks. First, to be as knowledgeable as possible of his or her system cost drivers down to the third or fourth work breakdown structure (WBS). Second, know how to marshal resources, primarily funding, to support good LCC ideas. [Ref. 11]

b. Selection Criteria

MTS candidates are proposed based on weapons systems that possess elements which currently, or in the future, will limit operational capability and readiness. The selection criteria consider a broad range of possibilities. First, all levels of spares are addressed when considering the most cost-effective potential solution. The selection process considers spares at the piece-part, component, subassembly, and subsystem levels. [Ref. 6, p. 24]

Second, MTS can be reactive or proactive in nature. Reactive MTS refers to the more common style of management of deployed systems, focusing on data such as: failure reports, high-cost spares, and usage rates. The AMC MTS Homepage likens this method to "a rearview mirror type analysis." [Ref. 3] Reactive metrics include: cost of maintenance, maintainability, reliability, operational use, supply availability, and configuration.

Proactive MTS refers to predictive analysis of the systems environment. It takes stock of the changing commercial environment, operational considerations, and technological considerations. Recognition of a changing commercial environment is critical to early identification of the impending loss of manufacturing sources, indicating approaching obsolescence. Proactive metrics may include: Diminishing Manufacturing Sources and Material Shortages (DMSMS), future system requirements, parts obsolescence, technology insertion opportunities, lower cost opportunities, and enhancement opportunities. [Ref. 3]

Finally, four elements are considered in the final approval of an MTS candidate. These four elements define what an MTS candidate must accomplish. First, it must result in a positive return on investment - the savings achieved must exceed the investment. Second, it must enhance readiness - through improved reliability or maintainability. Third, it must retain or enhance the previous capability of the system - there can be no degradation of performance. Last, it must result in lower life-cycle costs. [Ref. 3]

c. Pre-Milestone III

As mentioned earlier, an MTS initiative can take two forms, depending on the acquisition phase of the program. This difference in approach is readily apparent given the diverse nature of programs at opposite times. Figure 6 demonstrates the importance of the focus on pre-MS III programs. At this point (MS III), nearly 90% of the cumulative life cycle cost has been determined through design. Decisions made here have the greatest impact on O&S costs. [Ref. 24, p. 38] It follows that great emphasis should be placed on controlling LCC prior to this stage of a program.

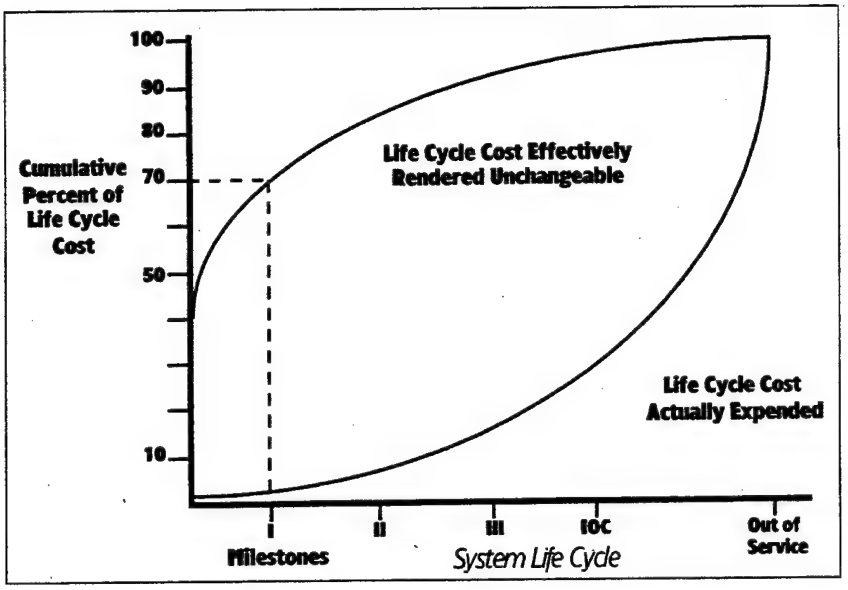

Figure 6: Typical Life Cycle Cost Commitment [Ref. 24]

In pre-MS III, the major focus is to "ensure developmental programs can continuously update the technology in spares throughout the system's useful life." [Ref. 6, p. 24] The goal is to design for future modernization. Open systems architecture, modular replacement, and software partitioning can all reduce costs of incorporating future modernizations. [Ref. 3]

d. Post-Milestone III

Using Figure 6 again, the importance of MTS during the post-MS III acquisition phase can be demonstrated. The majority of actual expenditures occur in the sustainment of a system – on average about 60% of total LCC. Therefore, a near-term cost savings can be realized through proper application of MTS. The reactive approach to MTS has the potential to identify many potential candidates in this phase.

Three MTS goals focus on the continually updating of spares during the post-MS III acquisition phase. These are [Ref. 3]:

- Update spares currently being acquired with modern technology where the cost benefit is the greatest

- Leverage spares procurement dollars to update technology within current funding levels
- Capture savings in spares acquisition and support costs for reinvestment in Army force modernization

During this phase, there is also a strong emphasis on performance specifications to improve spare design and performance. Manufacturing changes, contractor control of configuration items, contractor logistics support, and long-term contracts should be considered.

2. MTS Metrics

Metrics are the way to measure the success of an initiative. In this case, the metrics would be measures of the success of the MTS program. Unfortunately, the AMC MTS Homepage does not mention or discuss any appropriate metrics.

However, other generic sources do suggest certain metrics to measure the success of MTS. An MTS Update Brief presented at the Total Cost of Ownership Reduction Conference in July 1999 suggests the following as appropriate metrics [Ref. 25]:

- Number of technical data package (TDP) reviews
- Number of TDP conversions
- Realized cost savings

The TDP review and conversion addresses the number of spares specifications that have been reviewed and converted from detail specifications to performance specifications. The realized cost savings would flow from validated data on modernized spare parts.

3. MTS Benefits

Benefits that can be realized through MTS are varied. While all do result in some magnitude of dollar savings, many have other benefits as well. The following list of 10

programs is offered as anecdotal evidence of the range of benefits that can be achieved over a wide range of program and system types. [Ref. 26]

- Night Vision Image Intensifier Tubes – Reliability increased 33%; Per unit procurement cost decreased by 62%.
- Radial Tires for LRT 110 Mobile Crane – Tire life four times that of current tire; Commercial off-the-shelf (COTS) item; Cost savings commensurate with cost avoidance on replacement tires.
- Power Processor for Communications Shelter – Procurement cost reduced by $900 per unit; O&S cost savings of $178,000 per year; COTS components with reduced circuitry.
- M157 Smoke Generator Components – Reliability and reparability increased; System readiness increased by 20% - 30%; O&S savings of $600,000 per year.
- Voice Amplifier for Protective Masks – Battery change interval increased from 8 to 20 hours; Battery costs reduced 65%; 50% size and weight reduction; Acquisition costs for new amplifier remain the same.
- Enhanced Position Location Reporting System Hand-held User Readout – New procurement cost is 20% of old unit cost; Improved reliability and capability; Inserts commercial technology.
- Chemical Agent Monitor Sieve Pack Components – Improved reparability; Projected 10 year O&S savings of $7.2 million; False failures and indications eliminated.
- Helicopter Displacement and Directional Gyros – Projected 10 year O&S costs decreased from $110 million to $48 million. Inserts COTS.
- Circuit Card Assemblies for Firefinder Radar – Increased reliability; Reduced procurement and O&S costs; Logistical commonality with air defense radar.
- Control Display Unit for Radio Direction Finding System – Increased reliability and user-friendly; Field maintainable; New cost is 52% of original cost; Projected O&S cost savings of $11 million over 10 years.

4. Challenges

The AMC MTS Homepage has already identified some significant concerns involving implementation of MTS. Three of these potential problem areas and solutions are discussed below. [Ref. 3]

a. Integration With Other Cost Reduction Initiatives

It is important to realize that MTS is only one piece of the cost reduction puzzle. There is currently a lack of integration of MTS with these other initiatives to fully optimize the benefits of MTS and cost reduction.

There are many forms of cost reduction. Some have already been discussed in Section D of this chapter, such as SMA-OSCR, performance specifications, open systems, COSSI, Value Engineering, and HTI. Other critical initiatives exist, as well. For example, the Defense Logistics Agency Saving Through Value Enhancement (DLA SAVE) is a DLA funded program similar to MTS to reduce costs on DLA stocked components and parts. Also, the Dual-Use Technology Application Program attempts to leverage pre-existing commercial technology for application on weapons systems.

b. Incentives

The Army should require fewer spares, of improved reliability and lower price, over the life of a system under MTS. This may result in decreased sales for the contractor. This paradox results in insufficient, or ineffective, incentives for the contractor. The OIPT suggests potential answers to address both pre-MS III and post-MS III scenarios.

Pre-MS III program contractors require incentives prior to contract award. Therefore, during the preparation of the solicitation, the program could include evaluation factors such as:

- Increasing system reliability through the life of the contract.
- Reduction of life cycle cost models.

Post-MS III systems require a method to incentivize a contractor already awarded a long-term contract. There are three potential ways to accomplish this:

- Increase profit for the contractor.
- Good marks of performance for past performance consideration on future contracts.
- Consider teaming with the contractor in the fashion of Contractor Logistics Support (CLS). This stabilizes the contractor's work force.

c. Philosophy (Proactive)

The current acquisition culture appears to focus on reactive versus proactive modernization efforts. In other words, many MTS initiatives are occurring only when it is necessary – parts are so obsolete that they are no longer manufactured or too difficult to obtain at a reasonable price.

A recommended solution to this need for a shift to proactive modernization is the use of IPT's that fully integrated the use of predictive models. These models should be used throughout the system life-cycle.

F. CHAPTER SUMMARY

In summary, MTS is one of many programs designed through Acquisition Reform to reduce the LCC of weapons systems. Given the restricted budgets and accelerated aging of existing systems, O&S costs are rapidly rising. Simultaneously, the Army needs to fund Force XXI and Army Vision 2010 initiatives to meet the modernization plan

requirements of full spectrum dominance. MTS seeks to both control O&S costs and modernize systems through the incremental modernization of improved spare parts as existing spares attrit. This modernization is accomplished using O&M funds, freeing R&D and procurement funds for the fielding of new systems.

III. AVIATION AND MISSILE COMMAND PROGRAMS

> The U.S. Army Aviation and Missile Command has the largest spares acquisition budget at approximately $1.6 billion per year. This makes the need for Team Redstone to provide the soldier with the best equipment, at the lowest sustainment cost, and the highest readiness, critical to the overall success of the Army." [Ref. 27, p. 1]

A. INTRODUCTION

This chapter introduces the three AMCOM programs being evaluated: Patriot, Apache, and Comanche. Weapons system description and mission, MTS policy and strategy, and actual MTS initiatives (if applicable) for each program are discussed. Additionally, the draft AMCOM MTS strategy is discussed. The intent is not to analyze the program at this point, only describe the current environment.

B. PATRIOT

The MIM-104 Patriot High-to-Medium-Altitude Air Defense (HIMAD) system was selected based on the programs aggressive O&S cost reduction approach. The Patriot is a well-established system, going through evolutionary modernization, providing an excellent opportunity to evaluate the execution of an MTS strategy.

1. System Description

The mission of the Patriot is to provide "high- and medium-altitude defense against aircraft and tactical ballistic missiles of critical assets and maneuver forces belonging to the corps, and to echelons above corps; provide an advanced anti-tactical missile capability to the current fielded system." [Ref. 28, p. 183] A fire unit, or battery, consists of a phased array radar set, an engagement control system, an electric power plant, an antenna mast group, and eight launching stations. Each launch station contains four containerized ready-to-fire missiles. One such station is shown below in Figure 7.

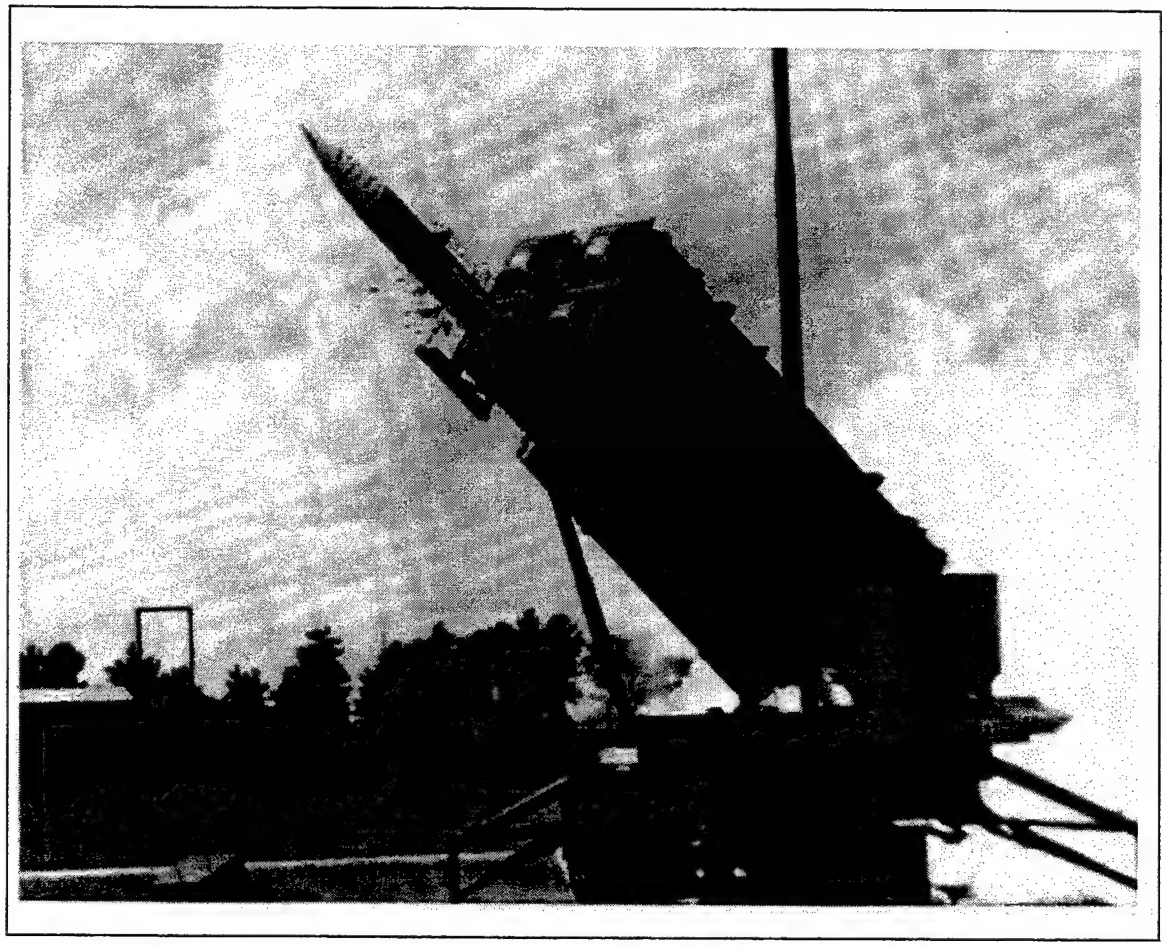

Figure 7: Patriot Missile [Ref. 29]

The first missile test launch occurred in February 1970. Full-scale development was initiated in 1976, and all developmental and operational trials completed in 1981, allowing the Patriot to enter production later that year. The first Patriot unit became fully operational in 1984. [Ref. 29]

Since that time, the Patriot system has undergone a nearly continuous program of product improvements to all components of the system. Consequently, there are as many as four different types of missiles currently in the inventory: Pre-Patriot Advanced Capability (PAC) 2, PAC 2, Guidance Enhanced Missile (GEM), and GEM+. The preferred and most capable missile is the GEM+ configuration. [Ref. 30]

While internal differences and capabilities within each missile version exist, there are similarities. Each missile is a certified and containerized round. It is fired from within the same box in which it is transported. Part of the design, the missile requires no testing or maintenance at the operator level. Periodic lot sampling of missiles, both in storage and on the launcher, is used to validate the round. On a time-based schedule, usually every ten years, each missile goes through a re-certification to tear-down, inspect, and repair the missile. The missile is then re-certified and containerized. A typical re-certification cycle costs about $125,000 per missile, with an additional $61,000 spent on repairs. [Ref. 30]

The Patriot's LCC O&S breakout is even more significant than the estimated Army-wide average of 60%. The Patriot program estimates that about 76% of total LCC fund O&S expenditures, while only 22% and 2% fund procurement and RDTE, respectively. [Ref. 31] Procurement for the Patriot for modifications is budgeted at $14.3 million in 1999, and $30.8 million in 2000. [Ref. 2]

2. MTS Policy

The Patriot program does not have a MTS policy that is separate and distinct from the AMCOM MTS policy, or the guidelines on the AMC MTS Homepage. However, the program has a Sustainment Cost Management Annex [SCMA]. The mandate of the SCMA was to "establish and implement requirements for a cost reduction plan/program for Total Life Cycle Costs (ACAT System) with emphasis on Operating and Support costs (O&S)." [Ref. Ref. 31, Slide 2]

a. Sustainment Cost Management

To accomplish sustainment cost management, the Patriot program has established an Ownership Enhancement Program (OEP) IPT. The OEP IPT's primary purpose is to "reduce O&S costs, operations, sustainment, and maintain readiness in the near, mid, and long terms." [Ref. 31, Slide 3] Unfortunately, the SCMA notes that the PM has only low influence on O&S costs during this stage of the program. This is critical given that 76% of the Patriot's LCC are O&S expenditures. It suggests that giving the PM greater influence on O&S costs could lead to increased savings. [Ref. 31]

The OEP IPT strives to assure Patriot viability, defined as readiness and responsiveness, in the future through the integrated execution of various O&S cost reduction initiatives. These initiatives focus on "high cost drivers that effect reliability, maintainability, manpower, training, test equipment, spares, technical data, obsolescence, modernization through spares, and facilities." [Ref. 31, Slide 8] Once identified, these cost drivers are matched to LCC Reduction funding programs, similar to those discussed in Section D, Chapter III, and shown in Figure 5.

b. Cost Drivers and Metrics

The OEP IPT has grouped cost drivers into five categories: military personnel, consumption, depot maintenance, modification, and all others. [Ref. 31] The military personnel section addresses the three-tier maintenance concept, and the number of personnel required to support the Patriot under this plan. The SCMA notes that the integration of an Integrated Diagnostic Support System (IDSS) would result in large O&S savings at the intermediate level through reductions in personnel end-strength, training, and travel. The "all others" group refers to the general O&S cost per battery.

More significant to this analysis of MTS are the consumption, depot maintenance, and modification cost drivers. Consumption and depot maintenance both address the rapid aging of the equipment and the need to replace high failure rate items and improve Reliability, Maintainability, and Supportability (RMS). Additionally, depot maintenance includes the need to renegotiate labor rates of major end items. [Ref. 31] Finally, modification focuses on the costs and funding issues of systems upgrades. All of these categories are closely linked to MTS objectives.

Additionally, the SCMA provides the Patriot program with a set of metrics, based on the cost drivers from above, to determine how successful the initiatives are at reducing O&S costs. [Ref. 31] Table 1 outlines these metrics.

Cost Driver	Metrics
Military Personnel	Reductions in intermediate maintenance personnel
Consumption	Mean Time Between Failures (MTBF), Failures/High Cost Spares
Depot Maintenance	Major end-item repair cycle
Modification	MTBF, Mod Kit Cost, Return on Investment
All	O&S Cost per fire unit

Table 1: Patriot System Metrics [Ref. 31]

3. MTS Initiatives

The Patriot program has a number of MTS initiatives being developed and managed under the control of the OEP IPT. Two of these include the Patriot Re-certification Program and the Patriot Solid State Data Storage System.

a. Re-certification Program

About every 10 years, each Patriot containerized missile returns to depot to undergo a re-certification process. The purpose of this process, sometimes referred to as R&R (Re-certification and Repair), is to inspect the missile round and effect any necessary repairs. The missile is then re-containerized and returned to the missile inventory as a certified round.

The Patriot Re-certification MTS initiative intends to modernize the entire inventory of non-GEM+ missiles to the GEM+ configuration through the R&R process. This would leave just the preferred GEM+ configurations for operational employment. The goals of the Re-certification MTS Initiative include [Ref. 30]:

- Upgrade to GEM+ configuration
- Replace obsolete components
- Significantly reduce OMA R&R costs
- Reduce re-certification requirements.

The initiative estimates it will provide a total O&S savings of $91.8 million from FY 1999 to FY 2010. Of that amount, it estimates a cost savings/avoidance of $14.3 million in FY 1999 alone. [Ref. 30] Additionally, the program estimates that the current re-certification period of 10 years could be increased to 15 years with the introduction of modernized, and more reliable, components [Ref. 44]. This would effectively reduce re-certification requirements and associated costs.

b. Solid State Data Storage System

The Patriot missile system uses an Optical Data Unit (ODU) to "transfer mission critical software for the operation of the weapon system." [Ref. 32] The ODU is experiencing increasing failure rates and its reliability is "significantly lower than

originally predicted." [Ref. 32] Additionally, the ODU is obsolete and can no longer be procured.

The MTS initiative for the ODU intends to replace the ODU with a Solid State Data Storage system (SSDS). The SSDS is simply a commercial solid state memory drive fitted with a modification kit, including rails and cables, to interface with the existing platform. The unit price for the current ODU is about $62,000 each, while the estimated unit price for the SSDS is about $39,000. The initiative suggests that replacing the ODU with the SSDS can generate three primary benefits [Ref. 32]:

- Mitigate Obsolescence
- Improve reliability (ODU MTBF – 16,500 hrs versus SSDS MTBF – 300,000 hours)
- Generate an estimated O&S cost savings of $81 million over five years.

This savings compares favorably with an estimated $2.25 million upfront OSCR investment to develop the new spare part. [Ref. 32]

C. APACHE

The AH-64 Apache Attack Helicopter was selected based on background knowledge of a potentially innovative approach to modernization – Apache Prime Vendor Support (PVS). Additionally, the Apache is the Army's most costly system to operate, providing the potential for the biggest savings. The Apache is currently undergoing a revolutionary modernization as the AH-64A is upgraded to the AH-64D Longbow Apache.

1. System Description

The Apache helicopter is the "world's premier heavy attack helicopter" [Ref. 12, p. G-15], and is a critical element of the U.S. Army's combat overmatch objective. The

mission of the Apache is to "conduct rear, close, and deep operations and deep precision strikes; provide armed reconnaissance and security when required in day, night, and adverse weather conditions." [Ref. 28, p. 125]

Figure 8: AH-64D Apache Longbow [Ref. 29]

The AH-64A has been widely recognized as the most advanced, combat-proven helicopter over the last ten years. The AH-64D Apache Longbow, the next generation version of the AH-64A, is even more capable. [Ref. 29] The AH-64A employs a Target Acquisition Designation Sight/Pilot Night Vision System (TADS/PNVS), laser, laser-guided Hellfire missiles, rockets, and a 30mm cannon to find, track, and attack armored targets. The AH-64D Apache Longbow adds advanced digital avionics, a millimeter-wavelength radar, a digital communications package, and improved Hellfire fire-and-forget missiles to the already lethal system. [Ref. 29]

The estimates gathered from early operational tests indicate AH-64D Apache Longbow improvements provide an array of benefits over the AH-64A. Among these benefits are [Ref. 29]:

- 400% more lethal
- 720% more survivable

- One-third the maintenance man-hour requirements.

It is true that the Apache is a dominant factor on the battlefield, but it's proven reliability and maintainability leave much to be desired. Drawing upon a General Accounting Office (GAO) report and a RAND Study, a clear and undeniable case can be developed to demonstrate the tremendous difficulties and challenges the Army faces in maintaining the Apache fleet.

In 1989, the House Armed Services Committee requested that the GAO to investigate low Apache availability and what the Army was doing to correct the problem. The GAO found that over the 18-month period during which the study was conducted, the Apache fleet averaged a 50% fully mission Capable (FMC) rate [Ref. 33]. This amount is 20% below the Army's stated goal of 70% FMC. Furthermore, the GAO found that the Apache required a high maintenance and logistic workload. Essential maintenance actions were required for every 2.5 flying hours. Demonstrated component failure fell far short of expected failure rates on many critical components. Maintenance and logistics could not keep up [Ref. 33].

The GAO report noted that the Army was aware of the problem and taking corrective actions, though the GAO considered the corrective actions inadequate. The Army's actions focused on improving reliability of components, availability of test equipment, and spares availability. The Army also planned to increase the number of contractor repair facilities and contractor maintenance personnel [Ref. 33].

A RAND study conducted in 1994 at the request of the Army focused on the TADS/PNVS (Target Acquisition Detection/Pilot Night Vision System) of the Apache. Using the failure rate data from Operation Just Cause (Panama) and Operation Desert Storm, they performed numerous statistical Monte Carlo simulations. They determined

that the Army's logistical system was too slow, and that too few spares were in the system to sustain the Apache fleet at adequate levels (about 70%) for longer than five days [Ref. 34]. Observing that the logistical system had not changed since the early 1990's, they recommended many philosophical and structural changes to the system. The changes were so dramatic that RAND suggested calling the new system precision-guided logistics, referring to their reliance on speed and information over mass. RAND was clearly advising the Army to look for new logistical support systems [Ref. 34].

Both the AH-64A and AH-64D helicopters are in the post-MS III acquisition phase.

2. MTS Policy

The Apache program has a large MTS policy posted on the Internet. The Apache policy closely follows the AMCOM policy guidelines.

The Apache program has established an MTS IPT that is a component of the Apache O&S IPT. The MTS IPT is broken into two sub-components: the screening group and acquisition group. The screening group identifies and assesses potential MTS candidates by using an Apache MTS Candidate Flowchart. The flowchart identifies the decision criteria and the various inputs to feed those decision criteria, such as existing databases, cost drivers, readiness drivers, DMSMS, and obsolescence studies. From this list of potential candidates, the screening group prepares a rank ordered list for the acquisition group. The acquisition group then determines a funding and procurement strategy for the MTS candidate. [Ref. 35]

The Apache MTS policy, similar to the Patriot program, notes that the Apache PM has input to, but does not control, the spares acquisition process. The program is forced to interface with the AMCOM MTS IPT, located within the AMCOM Integrated Material Management Center (IMMC), for input on the Apache spares acquisition strategy. [Ref. 35]

The Apache MTS Policy also notes that negotiations are currently underway to contract with Boeing for Apache Prime Vendor Support (PVS). In the event that the PVS contract is awarded, all MTS and OSCR initiatives will become the responsibility of Boeing. The PM will retain only oversight on the MTS program. [Ref. 35]

3. MTS Initiatives – Apache Prime Vendor Support

The Apache program is not actively engaged in any specific MTS initiatives. [Ref. 36] The primary reason for this is the PVS initiative, possibly the answer for new logistical support system recommended by RAND, being implemented by the Apache program. Under PVS, the Apache Prime Vendor, Boeing, will team with Lockheed Martin and General Electric to provide wholesale supply level support to the Apache helicopter. This team, called Team Apache Systems (TAS), becomes responsible for "cradle-to-grave" management of both the AH-64A and AH-64D aircraft. As such, TAS becomes responsible for MTS and any other O&S cost reduction initiatives.

It is important to note that as of 1 June 1999, the Apache PVS contract has not yet been awarded. While an alpha-contract was successfully negotiated with Team Apache Systems, the contract has yet to be approved by all elements in the Department of the Army. [Ref. 37] There are still many unresolved issues far outside the scope of this research.

Paul Hoeper, the ASA for AL&T, stated,

> Prime Vendor Support is a contractor logistics support approach that seeks to leverage the best commercial logistics practices to reduce operating costs while improving readiness. We are in the middle of looking at Prime Vendor Support for our Apache helicopters now. The preliminary news is very exciting. Prime Vendor Support could reduce the cost of operating an Apache by $800 per flight hour. This pencils out to a five-year savings of almost half a billion dollars. [Ref. 38]

Currently, the Apache costs approximately $3000 per flying hour, so this is a significant cost savings. In addition, not only costs are reduced, but the Apache fleet is also modernized as part of the Apache PVS contract. John Lund, the Lockheed Martin PVS Manager for TAS says, "Under PVS, wholesale support and fleet-wide modernization is provided on a firm-fixed price contract for less annual funds than current wholesale support expenditures alone." [Ref. 39]

What is truly revolutionary under PVS is that TAS is now responsible for the performance and reliability of those parts, and must provide performance guarantees. These guarantees are linked to an established number of flying hours each year. If the performance and reliability of the parts are sub-standard, then TAS is penalized; if they are above standard, then TAS is rewarded. TAS is also tasked with the configuration control management of the aircraft, a requirement traditionally held very closely by the Army. As part of that provision, TAS continually modernizes the Apache through improved spare parts. [Ref. 37] Boeing spokesperson Hal Klopper, noted that "Now the responsibility for obsolescence falls on us." [Ref. 40]

The Army retains control of critical airworthiness releases and safety of flight messages under Apache PVS. Additionally, although the Army gives TAS control of the design down to and including configuration items, they retain control of configuration as

it relates to interoperability with other battlefield systems [Ref. 37]. This is an important feature to ensure seamless interface with other systems in an increasing digital battlefield.

The estimated benefits from Apache PVS support are enormous. They include, but are not limited to [Ref. 39]:

- 25% reduction in spares and repair cost
- Support modernization goals
- 25% reduction in inventory investment
- Decreased management burden for DoD.

D. COMANCHE

The RAH-66 Comanche Reconnaissance/Light Attack Helicopter was selected because it is a relatively new system still in development. The Comanche, the Army's most expensive acquisition program, does not expect to achieve Initial Operational Capability (IOC) until around 2007. The Comanche provides an excellent opportunity to review what a pre-MS III program is planning through MTS to reduce LCC.

1. System Description

The RAH-66 Comanche is the Army's next generation two-seat reconnaissance and light attack helicopter. It will perform the armed reconnaissance mission for attack helicopter and air cavalry units. It is expected to significantly enhance the Army's ability to conduct reconnaissance operations in all battlefield environments. [Ref. 28]

The Comanche is currently Army aviation's highest priority. The Army is funding the developmental program with over $1 billion in FY 1998 through FY 2000. [Ref. 2] It is expected to provide leap-ahead technologies, especially in the areas of stealth, information dominance, and combat overmatch objectives. Like the AH-64D Apache Longbow, the Comanche is a critical part of the future digital battlefield. [Ref. 12]

Figure 9: RAH-66 Comanche [Ref. 29]

The Comanche is being developed with special attention being paid to the maintainability and reliability of the aircraft. Modular design and open systems are widely employed throughout the aircraft. Digitization and automation initiatives to improve self-diagnostic capabilities and support maintenance and logistics functions are employed to improve logistical responsiveness. [Ref. 12]

The Comanche program expects to enter the Engineering, Manufacturing, Development (EMD) acquisition phase (still pre-MS III) by mid-2000. [Ref. 42]

2. MTS Policy

The Comanche MTS Policy is a short document designed around five principles: performance specifications, IPT's, modular design, Cost As an Independent Variable (CAIV), and Contractor Logistics Support (CLS). The Comanche program feels these five principles are the "enabling capabilities that will facilitate and support the use of MTS." [Ref. 41]

The specifications for the Comanche are titled the "Performance Weapon System Specification," indicating the emphasis on performance over detail specifications. Each paragraph of the Statement of Work (SOW) addresses programmatic or functional requirements, not specific directions. The contractor has complete authority to utilize the best of industry and commercial standards in the design, development, and upgrade of the

Comanche. The Comanche program feels this approach will "promote the most effective upgrade of component spares." [Ref. 41] It is critical to note that to provide for future interoperability and interchangeability, the contractor will completely document functional and physical interfaces only in TDP's.

The contractor will retain configuration control and management over the remainder of the components within the Comanche for the first five years after Initial Operational Capability (IOC). This process, known as CLS, allows the prime contractor to manage all spares and repair parts. The Comanche program has integrated performance incentives into CLS to motivate the attainment of performance and modernization goals through the modernization and insertion of new spares and technologies. At the end of this five-year period, future contract options will be considered to continue CLS.

The modular design of the Comanche intends to leverage performance specifications to promote an open-systems architecture. The combination of performance specifications and open-systems design hopes to capture "the inherent flexibility that encourages and supports incorporation of performance, producibility, and system readiness improvements via spares acquisition." [Ref. 41] This flexibility should ensure "that the door for the use of MTS stays open from both a technical and cost standpoint." [Ref.42]

3. MTS Initiatives

The Comanche, as a Pre-MS III program, does not have any specific MTS initiatives. Comanche was selected specifically because it is still in development. In this respect, the focus is to analyze what the Comanche program is doing to prepare for future MTS initiatives.

E. AMCOM MTS STRATEGY

The AMCOM MTS Strategy is posted on the Internet, as directed by AMC. However, the policy has yet to be formally approved by AMCOM, and therefore should be considered a draft policy. It has been in draft format awaiting signature for a minimum of nine months.

The AMCOM Integrated Material Management Center (IMMC) provides leadership for MTS at AMCOM, and is the author of the AMCOM MTS Strategy. Specifically, the Logistics Lab at IMMC has the lead role for developing an integrated O&S cost reduction program, and will represent the AMCOM at the MTS OIPT. It is responsible for assisting all programs within AMCOM in applying modernization principles to the spares acquisition process. The Logistics Lab will [Ref. 27]:

- Develop and maintain the MTS Implementation Plan
- Charter and chair the MTS IPT at AMCOM
- Provide MTS training to AMCOM and associated PEO's
- Establish and report MTS metrics
- Maintain MTS Opportunity Reports

1. Goals and Objectives

The strategy outlines four goals and seven objectives. Most of these reiterate Army-wide MTS policy. A few, however, are especially noteworthy. For example, one of the goals of the strategy is to ensure that MTS is systematic rather than opportunistic. This goal is echoed in one of the objectives to "implement a systematic and disciplined review of the spares procurement processes for MTS candidate selection methods." [Ref. 27] The last objective to be specifically mentioned here is to establish metrics for evaluation and feedback on successes of MTS initiatives to Program Managers. [Ref. 27]

2. MTS Process

The MTS strategy being employed at AMCOM involves a three-step process of identification, assessment, and execution. The process, shown Figure 10, provides for a formal implementation plan, as well as a fast-track approach. [Ref. 27]

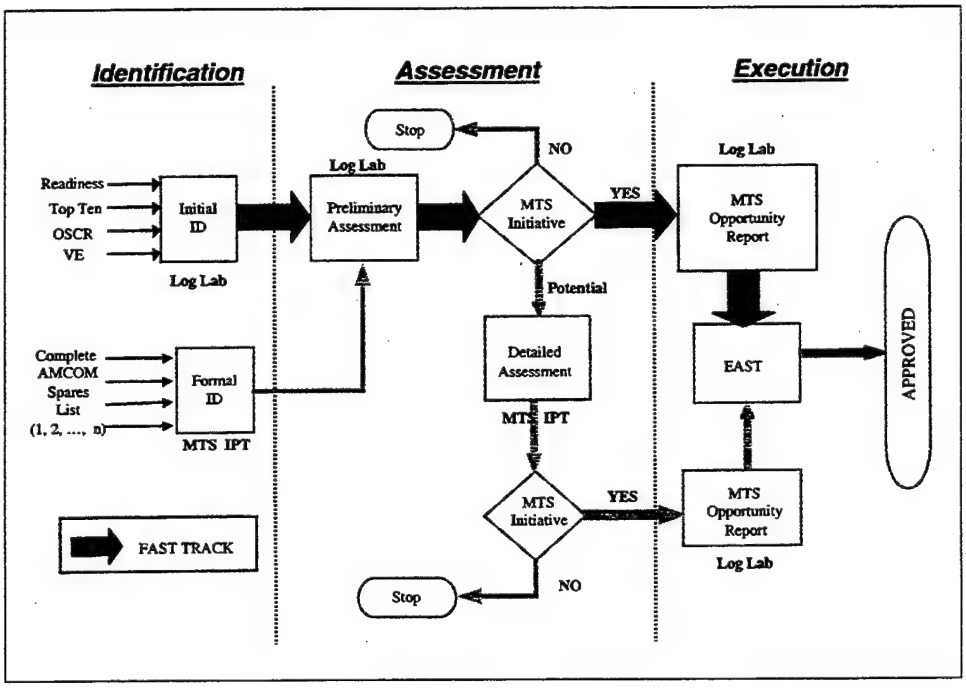

Figure 10: AMCOM MTS Methodolgy [Ref. 27]

3. Candidate Identification

As Figure 10 demonstrates, there are two distinct approaches involved: fast track and formal. Each one provides for a different method of identifying potential spares for MTS. In practice, the strategy recommends that programs should first implement the fast-track method, and then follow with the formal method. Fast-track attempts to realize immediate savings through MTS, while the formal approach answers the need to institutionalize MTS by conducting a very thorough and systematic analysis of all spares used within the command. [Ref. 27]

The fast-track method focuses on certain sources of readily available data on a specific system that may be used to quickly identify a potential candidate. These include [Ref. 27]:

- Top Ten O&S cost drivers
- Top Fifty readiness drivers
- OSMIS
- OSCR candidates
- DMSMS studies

While the first two are self-explanatory, the others may not be easily understood. OSMIS, or Operations and Support Cost Management Information System, is an existing database that collects and reports information on selected spare parts usage on over 200 systems. It is often used to predict future spares requirements. OSCR candidates are those O&S cost reduction candidates that were selected through other initiatives, such as SMA-OSCR. Last, DMSMS studies provide short and long-range outlooks on the future of spares procurement given the manufacturing technology and base. [Ref. 27]

4. Metrics

The strategy outlines two sets of metrics: schedule-based and O&S cost savings/avoidance-based metrics. [Ref. 27]

The schedule-based metrics, similar to those suggested in Chapter 3, involve the TDP's for a given system. They include [Ref. 27]:

- TDP reviews of the top ten cost drivers
- TDP reviews of all other spares
- TDP conversions to performance specifications planned
- TDP conversions to performance specifications completed

The estimated O&S cost savings/avoidance metric simply estimates the O&S cost reduction realized through the implementation of an MTS initiative. It is designed to be based on a cost-benefit analysis over a ten-year period, and mirrors the reporting format required by AMC. [Ref. 27]

5. Barriers

Interestingly, the AMCOM Strategy clearly notes seven barriers to implementation of MTS. [Ref. 27]

- Instability of requirements and relationships, and lack of up-front funding by the Army. This does not adequately motivate contractors to invest in MTS initiatives. Funding limitations within the AWCF present a problem for aviation and missile commodities, given their cost and complexity.
- Re-qualification costs and risk management analysis can be steep. This could be especially significant given the complexity and airworthiness release requirements for aviation and missile systems.
- Inadequate interface and test requirements.
- Lack of funding for institutionalization of MTS.
- Inability to reinvest the estimated MTS savings in additional MTS initiatives. The savings are not reflected in additional funding for the programs that are generating the savings.
- Contractor logistics support, prime vendor support, and configuration control management all present challenges for a program attempting to implement an MTS program.
- Lack of funding for hardware and/or software changes.

The issue of funding is noted repeatedly as a significant problem. MTS does not have its own funding line, yet requires resources to accomplish its objectives. Development of tools and techniques for use in MTS, programmatic institutionalization of MTS, and support for the MTS IPT all require resources that are currently not provided in a distinct MTS fund. [Ref. 27]

AMC has also constructed additional funding constraints, noted in the AMCOM strategy, as potential barriers to implementation. AMC formulated guidelines that limit initiatives to maintenance-based requirements that do not have system level improvement as the principle intent. Furthermore, modification kits, often required to institute an MTS initiative, may not be purchased using AWCF. [Ref. 27]

F. CHAPTER SUMMARY

In summary, each of the three systems has taken a different approach to implementing MTS. The legacy system Patriot has implemented an all-inclusive O&S cost reduction IPT within the program office. This OEP IPT has responsibility for improving performance and reliability at a reduced cost. The Apache is following a path that incentivizes the prime contractor, under PVS, to implement MTS. Last, the Comanche approach is a function of the early acquisition phase of the program. Therefore, the intended MTS influence is on open-system design to performance specifications. All, however, do advocate policies that are striving to reduce the cost of operating their respective system using improved spares and leveraging O&S funding. Finally, there exists a number of externally imposed barriers to implementation of MTS. These barriers have been recognized and documented by AMCOM.

IV. IMPLEMENTATION ANALYSIS

A. INTRODUCTION

This chapter analyzes the MTS approach being implemented in these three programs. It examines the example MTS initiatives previously introduced. It focuses on implementation policies, oversight, impacts on cost, schedule, performance and risk, funding, metrics, incentives, realized benefits, challenges, and integration with other life-cycle cost reduction initiatives. It concludes with a generalized lessons learned from the applications of MTS within these three programs so that they will be useful to applications of MTS in other programs.

B. PATRIOT

1. Re-certification Program

The Patriot re-certification program should not be considered an example of an MTS initiative. Instead, it would be more appropriate to classify the program as a block upgrade. One of the critical elements of MTS is that the spare parts are replaced through the process of attrition. In this manner, maximum value of the existing part is realized. It is replaced only when the existing part fails, or is expected to fail shortly. Incremental modernization is achieved through this process. This is clearly not what the Patriot re-certification is attempting to accomplish.

The goal of the Patriot program is to modernize the inventory of non-GEM+ missiles to the GEM+ configuration. This process requires the upgrade of a number of components (depending on what version the missile was to start with) regardless of their condition. This type of modernization is a block upgrade – a grouping of upgrades to achieve a more capable system – to the GEM+ missile.

The method of funding for a block upgrade versus an MTS modification is greatly different. In the case of a block upgrade, the funding for the development should flow from R&D funds, while the funding for the purchase should be from procurement funds. In the MTS case, the developmental funding would come from some program such as OSCR, and purchasing would be as for any spare part – O&M dollars. In this particular case, the Patriot program is leveraging O&M dollars, both through OSCR and maintenance accounts, to fund a project that should be funded as a block upgrade using R&D and procurement dollars.

The return on investment (ROI) appears positive, but the magnitude is unclear. Early briefings indicate savings of $91.8 million over ten years. A different Patriot program office memo estimates $23 million over the same period. [Ref. 43] Additionally, the development cost of this "block upgrade" is not provided. This makes it difficult to identify the actual ROI. The inconsistencies on the dollar amounts and incomplete data do not lend credibility to the initiative, even though some savings appear feasible.

The Patriot program claims readiness is enhanced through the re-certification program. They state that both the improved reliability of the new components and their increased capabilities contribute to the increased readiness of the Patriot system. It is reasonable to accept their hypothesis, since newer technology tends to have increased reliability, and the components do improve system capability. However, the quantifiable amount of just how much readiness is increased is unavailable. It is expected, though, that the improved components may increase system shelf life by 50%, or about five additional years. This longer time between re-certifications will clearly save in total LCC.

However, the program is not an example of an incremental improvement through the process of attrition, a hallmark of a true MTS initiative. Instead, it is a one-time block upgrade in the depot, returning a dramatically improved missile to the inventory.

2. Solid State Data Storage System

The SSDS more closely replicates the classic MTS approach. There are clearly defined needs for a modernized component including obsolescence and the non-procurable nature of the existing component. Also, the ROI is clearly positive, readiness is dramatically improved, capability is enhanced, and the overall result is reduced LCC.

The SSDS will begin fielding in the summer of 1999, using an attrition-based strategy. Since the SSDS requires a special installation kit, the program office will fund installation of the kit one battalion at a time. As a battalion completes installation of the modification kit, and an existing ODU fails, the improved SSDS will be available through normal supply channels. Given the current ODU failure rates, the program office estimates that the entire inventory of ODU configured systems will be replaced with SSDS configured systems in a little over one year.

The developmental funding for the SSDS was through the OSCR program. The procurement of the SSDS will occur through normal supply channels using O&M funding. Finally, the installation kits will be purchased using program office funds (procurement dollars) since AWCF funds may not be used for the purchase of modification kits. Clearly, the funding effort is in agreement with the guidelines established by MTS.

The reduction of estimated an $81 million in system LCC, on an investment of under $3 million in developmental OSCR funds, results in a positive ROI. This,

combined with the attrition approach, improvements in readiness, and improvements in capability demonstrates the powerful approach of MTS.

3. Ownership Enhancement Program

Although this analysis is critical of the funding methods of the Patriot re-certification initiative, it favorably notes the OEP IPT approach employed by the Patriot program and the results it achieves. Dean Anderson, Staff Logistician at the Air & Missile Defense PEO, views MTS as one support under the complex umbrella of O&S cost reduction efforts shown in Figure 5. [Ref. 44] He believes that the MTS objective, in spirit, is a good one, but the implementation is poor.

His analysis addresses the independent approach of MTS from other O&S cost reduction initiatives and the method of implementation. He firmly believes that MTS should not be approached as an independent system. Rather, it should be viewed as an inherent function of any good O&S cost reduction program, to be considered as an integrated element with other initiatives. [Ref. 44] The OEP IPT is responsible for the development and initiation of any projects designed to reduce sustainment costs for the Patriot [Ref. 43]. Dean Anderson stated that a well-integrated, internal O&S cost reduction program, combined with a joint service, or external, effort would yield the best all around LCC reductions. [Ref. 44] It clearly provides the best forum for addressing the complex relationships of LCC reduction opportunities and LCC reduction funding programs.

He also suggested that the MTS emphasis on TDP conversion to performance specifications is not particularly meaningful. [Ref. 44] In fact, "the conversion of the technical data packages to performance specifications was examined and found to be cost

prohibitive due to the age and maturity of the system." [Ref. 43] It is important to note, however, that developmental systems, such as PAC-3 are performance specification based, making future TDP conversions unnecessary.

Since the Patriot program does not convert all of the TDP's to performance specifications, they do not report the TDP metrics required by AMC - numbers of TDP's reviewed and converted. One Patriot document defends that position, stating unequivocally, "Although Patriot does not meet the criteria for the MTS metrics reporting parameters, Patriot is actively engaged in the reduction of O&S costs." [Ref. 43] Instead, the Patriot program OEP IPT reviews cost drivers and potential ROI prior to selection of an MTS candidate. This process is much more efficient and effective at focusing on high ROI initiatives.

Finally, Dean Anderson noted the lack of a separate funding line for MTS, especially in the pre-MS III acquisition phase, as a real detriment to implementation. [Ref. 44] A program needs funding to implement MTS, or any other OSCR initiative. Without that necessary funding, which should be viewed as an investment, the program may possibly be unable to execute any LCC reduction efforts.

It is clear from the research that the OEP IPT attempts to integrate the MTS strategy with other O&S cost reduction strategies. Consequently, a well-intentioned modernization, such as the Patriot re-certification program, might receive a questionable funding line, but that is not significant given the complex relationships of LCC reduction programs and the end-goal of O&S LCC reduction. The integrated OEP IPT is an excellent approach to MTS and LCC reduction.

C. APACHE

1. Prime Vendor Support

The Apache PVS contract is written for a single year, with four option years to follow. The option years are designed in to allow the Army to make significant adjustments to the flying hour program as the budget evolves and security issues change. Over this 5-year period, the Army expects to benefit from an overall 16% decrease in Apache O&S costs. [Ref. 37] This estimate presumably includes all MTS or OSCR development charges, since these are the responsibility of the contractor.

There are numerous incentives built into the contract; so many incentives that Bruce Metzger, Apache contracting officer, referred to the contract as a "FFP with incentives." [Ref. 39] John Lund, from TAS, stated that, "The program employs a unique combination of contractor requirements, cost incentives, and performance obligations." [Ref. 39] For example, TAS is responsible for overall system performance. If TAS fails to provide the adequate number of flying hours because of poor system performance, not only are they not paid, they also incur a monetary penalty. Conversely, if they provide more than adequate availability, and they do it at less than the negotiated price, they keep almost all the additional funding as profit. This is an enormous incentive for the contractor to modernize high cost and low reliability drivers.

If TAS provides such a superb logistical system that they are able to reduce the number of spares required to support the Apache fleet, then TAS must share the savings (50/50) with the government [Ref. 37]. However, if TAS requires additional spares above the negotiated level to keep the Apache availability adequate, it comes out of their profits. Therefore, this 50% sharing arrangement on spares inventory level generates savings for

the Government and TAS only if TAS requires fewer spares. It generates additional cost to TAS if they require more spares. Assuming TAS will employ an advanced logistical system, this also directly motivates them to improve spare reliability.

Threats to PVS are coming from many directions. Valid concerns from the advocates of Horizontal Technology Insertion (HTI) about the decreased commonality across platforms because of PVS (primarily due to loss of configuration management) must be addressed and weighed. The concern would be that multiple contractors, all developing their own advanced technologies, would not willingly leverage useful technologies developed elsewhere for inclusion in their system, or divulge their own profitable strategies to potential competitors. Having provided complete CI control to the prime vendor, the program office might find it difficult, if not impossible, to institute HTI initiatives. In addition, there are Army Working Capital Funds (AWCF) issues. When (if) the Apache abandons the AWCF to proceed with PVS, the structure of funding other programs through the AWCF shifts dramatically. The Apache alone comprises one-sixth of the entire AWCF. With the mark-up on Apache parts at about 22% on revenues of $543 million annually, it follows that AMC might lose as much as $50 to $60 million annually in surcharges to support operations [Ref. 45]. The overhead associated with the AWCF previously absorbed by the Apache must be absorbed by all the other systems, dramatically raising other program's costs.

However, "PVS provides a new paradigm in acquisition improvement and has great opportunities for cost savings and self-sustaining modernization through spares if the system contractor retains system performance responsibility." [Ref. 45] The benefits of PVS to MTS and LCC reduction must be weighed against the challenges.

2. 2nd Generation FLIR

Another built-in incentive in the PVS contract involves MTS and the TADS/PNVS upgrade, or 2nd Generation FLIR. While the Apache program does not market this modernization as an MTS initiative, many elements of the implementation are similar to MTS approaches.

This system is the number one cost driver on the Apache, which is the number one maintenance cost driver in the Army. The Army is combining a pre-agreed $250 million FFP contract to modernize six of the eight components of the TADS/PNVS with the PVS contract. [Ref. 37] This program will be funded through savings realized from the PVS contract. "The 2nd GEN FLIR program is expected to start in FY '01 with modernization of the fleet through spares." [Ref. 46] In other words, the TADS/PNVS will be modernized with 2nd Generation FLIR components as existing components are removed due to attrition.

The goal is for TAS to develop spare components that are compatible with both the current and follow-on generation of TADS/PNVS. In essence, the Army will not be purchasing and maintaining spares that will shortly be discarded. This should not only lower procurement costs for the Army, but development and logistics costs should be driven down for TAS as well. The Army expects about $300 million to $400 million in savings from this MTS innovation alone. [Ref. 37]

3. Current Status

The Apache program has posted a very elaborate MTS strategy on the Internet. Their process is in concurrence with AMCOM and AMC MTS directives. Unfortunately, the Apache program is currently not very active in any MTS initiatives. The 2nd

Generation FLIR initiative is more an offshoot of PVS, and not a true and independent MTS initiative. The anticipated awarding of the PVS contract, discussed above, has made it difficult for anything to get accomplished with respect to MTS initiatives. Chuck Wright, Total Ownership Cost Reduction (TOCR) point-of-contact for the Apache program, noted PVS, funding constraints, and management of spare parts as inhibitors to the MTS effort.

The funding constraints enacted by AMC have limited MTS developmental initiatives to $250,000, without waivers from AMC. [Ref. 47] While this might be adequate for simple spare parts, the Apache is not a simple system. Aviation components are extremely complicated, and often very expensive. Since the PM is already short on funding, this limitation effectively restricts initiatives into LCC reduction for complex systems and components.

To compound matters, Mike Bahnen, a former Apache program logistics member noted that, as a matter of precedence, when costs are reduced, next year's funding is also reduced. This does little to incentivize a program to initiate an OSCR initiative, and obviates the need to establish a separate and independent funding line for MTS. [Ref. 36]. It is interesting to note that while a contractor would receive 50% of any savings under PVS as an incentive to reduce costs, program offices not only receive no incentive, they actually realize a reduction in their following year's budget. That is actually a disincentive.

This lack of incentive carries over to the contractor, as well, when not under PVS. Mr. Bahnen stated it would be "a fairy tale to think MTS is incentivized." [Ref. 36] He recommended long-term relationships with proven contractors to help overcome the

losses in revenue that fewer and more reliable parts will bring to the contractor. The addition of penalties for failure to meet reliability goals (such as MTBF) would help protect the acquisition program.

The other factor inhibiting the application of MTS is the management of the spare parts. Both Mike Bahnen and Chuck Wright noted that the IMMC control over the management of spare parts was detrimental to the MTS effort. [Ref. 36, 47] IMMC controls the management of the spare part and the TDP. Under this system, the Apache PM "has input to, but is not responsible for and does not control, the spares acquisition process." [Ref. 35] It is difficult to truly make the PM responsible for LCC reductions, when he or she only has an advisory role over the management of the critical spares process.

The result is that the Apache program does not really have an active MTS program. In effect, the excellent MTS methodology developed on the Apache MTS Homepage amounts to checking the block. They have posted an MTS strategy, while they hopefully await the award of the Apache PVS contract to TAS.

D. COMANCHE

1. Implementation of MTS

As a developmental program, the Comanche does not have any active initiatives to evaluate. However, they do have an excellent pre-MS III MTS approach that they are implementing. Dennis Mcguire, a Logistics Management Specialist for Comanche, observed that the AMC MTS Homepage was very helpful, and that the general themes of the Comanche policy were crafted from this site. He did note that the site was lacking specific details, though, for executing a pre-MS III MTS program. To this extent, he

recommended both the provision for a DAU course focused on pre-MS III MTS, and development of a body knowledge with practical MTS examples. Given the knowledge that about 90% of total LCC are determined through design prior to MS III, the benefits of these recommendations could be quite significant. [Ref. 42]

Dennis Mcguire was also concerned about the availability and quality of the metrics used in MTS. First, he noted that there are no MTS metrics established anywhere for developmental programs, and therefore no barometer for which to measure their program's progress. And although the Comanche is based completely on performance specifications and does not require TDP conversions, he questioned the relevance of the TDP metrics. The conversion of TDP's costs a program office much time and money. [Ref. 42]

The five principles of the Comanche MTS program are excellent goals to seek, and should prepare Comanche for success in terms of reducing LCC. "Performance specifications, coupled with an open systems design, should result in a design that remains flexible and thus, subject to continual update throughout its life cycle." [Ref. 42] Logistics engineers are continually used in Comanche IPT's to review the Comanche's designs to evaluate the ability to accommodate MTS objectives. However, increasing challenges in development resulting from operational requirements continue to push Comanche weight and cost concerns. These conflicting goals could limit the use of open systems and modular design, critical to MTS, to keep Comanche weight and costs down. Unfortunately, the cost savings in this scenario would only be short-term, as long-term LCC rise higher than they might have otherwise due to the inclusion of proprietary

components. Addressing MTS, Dennis Mcguire stated that "Near-term higher costs should be viewed as worthy investments if they can produce lower LCC." [Ref. 42]

2. Incentives

Addressing the complex, and often overlapping relationships between LCC reduction opportunities and funding programs (Figure 5), he suggested a higher headquarters assessment on all initiatives to ensure that "they all integrate in a synergistic manner." [Ref. 42] He even suggested the relaxation or elimination of the "rigid separation line between pots of money such as procurement versus O&M." [Ref. 42]

One of the most striking and disturbing comments from this entire research came from Dennis Mcguire, referencing this confusing funding program approach. "I've sat in MTS discussions where PM's have expressed fear that if they used OMA dollars to seek MTS improvements, then they would be violating legal restrictions on the use of established funding." [Ref. 42] This comment truly reveals the need to study the complex funding and color of money issue. The fact that PM's may not introduce good LCC reduction initiatives because of this situation is clearly detrimental to the implementation of MTS, and jeopardizes total ownership cost initiatives.

Instead of disincentivizing MTS, Dennis Mcguire suggests permitting the program office to retain any savings that accrue as a result of the incorporation of an MTS initiative. [Ref. 42] These savings could be rolled back into additional MTS initiatives or other system modernization efforts aimed at the reduction of LCC. "The true value of MTS is to the extent that it improves the overall quality of the weapon system." [Ref. 42] Any measure that can be undertaken to improve value - reduced LCC and/or improved performance – should be incentivized. PM's should consider the costs

associated with MTS as investments in the future. Letting them retain some or all of the savings for the value improvements they are incorporating would be a positive step.

E. LESSONS LEARNED

There are many lessons to be learned from this analysis. Some of these apply directly to the example programs, and others apply to the development of any acquisition initiative.

1. MTS Benefits

The MTS process has the potential to generate large cost savings/avoidance, as seen in the Patriot program and estimated for Apache PVS. Understanding that the process is a more effective and efficient solution when integrated with other LCC reduction programs can increase the potential benefits. The benefits of MTS include improved capability, enhanced readiness, and reduced LCC. These benefits can help the Army realize their modernization goals through upgraded equipment and increased funding for new weapon systems.

2. Funding Considerations

The color of money issue is very detrimental to the execution of any LCC reduction effort. This especially holds true for MTS, since no separate funding line exists. PM's feel constrained in their efforts to implement cost reduction initiatives.

Funding restrictions on MTS may be even more painful for aviation and missile systems, given the greater complexity and testing requirements, and therefore higher developmental costs for spares. Limitations on funding potentially restrict the development of MTS initiatives on spare parts that might provide the vastly greater returns on investment than smaller, less complex parts.

Funding is especially critical during the pre-MS III acquisition phases of a program. Since nearly 90% of a system's LCC is determined by MS III, funding for future potential MTS or LCC reduction efforts has a large impact. Comanche is experiencing operational requirements challenges, driving up weight and costs. Without dedicated MTS funding, shortcuts may have to be taken that save a little now, but cost more in the long-term.

3. Incentive Considerations

Incentives are the way to make programs work. The Government regularly commits to incentive type contracts with commercial and private industry to motivate certain types of behavior. Yet, MTS does not enjoy any incentives. In fact, the threat of making mistakes in color of money concerns or losing future funding because of LCC savings is actually a disincentive. "To fully benefit efforts in O&S cost reduction, some proportion of resources realized through upgrading systems or parts savings at the unit level should rebound to the PM for further investment." [Ref. 11, p. 12]

Programs such as PVS and CLS are also excellent ways to incentivize the use of MTS. The contractor understands that any savings generated through the employment of more reliable parts is additional profit.

4. Metrics

Metrics for MTS are inadequate. Each program analyzed noted the meaninglessness of the TDP metric. To paraphrase and generalize their responses, they said "Who cares how many TDP's are reviewed or converted...And besides, that costs money...What about the ROI?" Programs do not have any proposed way to gauge their progress for developmental programs, and only marginal metrics for post-MS III

programs. Fortunately, all new systems are being developed under the premises of performance specifications, eliminating the requirement for costly TDP conversions in the future.

5. Validation/Audit

Validation of current MTS initiatives is sorely lacking. Patriot appeared to not have a good handle on MTS development costs or understand what actual LCC savings would amount to once implemented. Estimates varied widely. This information is critical when evaluating a potential MTS candidate.

6. PM Responsibility For LCC

Two programs, Patriot and Apache, specifically noted the difficulty in managing LCC given that the IMMC controls the management of spare parts. At best, the programs act in advisory roles to the IMMC in matters concerning spare parts. Due to the recent push to formalize PM responsibility for total LCC, not just development and procurement costs, this would appear to be a problem. The PM "now has the mandate to implement a systematic program consisting of a mix of planned system upgrades and retrofits, MTS strategies, and other investment methods." [Ref. 11, p. 10] Some consideration should be given to who manages the spares given this new mandate.

7. Shared Knowledge

Currently there exists an AMC MTS Homepage, and a myriad of other websites describing MTS policies and examples. However, each one reviewed in this research, with the exception of the AMC MTS Homepage, focused solely on post-MS III MTS initiatives. Moreover, the AMC site is very cursory in its level of detail relating to pre-

MS III initiatives. Consequently, there is a real lack of resources for new start programs to research for ideas for establishing a detailed MTS program.

In addition, most programs approached MTS as directed by the AMC MTS Homepage – as a separate program. By doing so, these programs lose the benefits attainable under an integrated O&S cost reduction program.

V. CONCLUSIONS AND RECOMMENDATIONS

> The MTS Program is the principle means to upgrade subsystems and spares to incorporate more reliable and less costly technologies in an efficient manner. [Ref. 11, p. 11]

A. CONCLUSIONS

MTS is a revolutionary approach on the management of legacy system LCC for the Army. It strives to achieve incremental modernization of Army systems through the attrition of obsolescent spare parts, and subsequent insertion of modern technologies. While examples of MTS-like actions in the Army exist from the past, they tended to be purely out of necessity. Either a part was needed and no longer manufactured, or the existing part was so unreliable or incapable of performing that something had to be done. Cost was often not a major factor. Now, given the current geo-political environment, cost is equal in magnitude to performance and schedule. Consequently, it has become necessary to identify methods of reducing system LCC in order to maximize the limited funding available. MTS is only one of many O&S cost reduction initiatives developed to achieve this goal.

MTS has a number of criteria that distinguish it from other LCC reduction programs. To accurately define a LCC reduction initiative as an MTS approach, it must:

- Generate a positive ROI
- Enhance readiness (reliability and maintainability)
- Enhance or retain capability of the legacy system
- Result in lower life cycle costs
- Be implemented through the process of attrition
- Leverage spares procurement funds (OMA dollars) to purchase spares

What truly makes MTS unique is that it attempts to institutionalize cost reduction awareness during all acquisition phases of a program. The goal of MTS is to realize meaningful O&S cost reductions through a mechanistic versus opportunistic approach. As recently as late 1997, though, the ARIAT noted that MTS was still opportunistic in its approach to spares modernization. [Ref. 3] One recent attempt at "mechanization" of the approach was to require the review and conversion of TDP's to performance specifications. However, given the high cost of converting TDP's, especially in time, and lack of funding, many programs find this TDP solution inefficient and ineffective. Therefore, it might be reasonable to expect some level of opportunism on the part of programs.

MTS has growing pains that need to be addressed to make it a viable approach for the long-term. This research identifies six categories for focus: funding, incentives, metrics, conceptual approach, information management, and program management responsibilities to LCC reduction.

Of these categories, one worth additional focus is the MTS conceptual approach. MTS should not be treated as an independent LCC reduction program. It should be treated as an integrated element, or one arm of the LCC reduction umbrella, as Dean Anderson from the Patriot program advocated. Throughout this thesis, the terms MTS and LCC reduction were used almost interchangeably. That type of integration, or blurring of boundaries, should be used in the execution of any program. Separation of approaches limits opportunities, while integration provides opportunities, like for the Patriot OEP IPT.

The primary research question was to determine what improvements can be made to MTS and how could incentives for the program be improved. Part of the reason for this approach stems from the realization that several good acquisition reforms have been developed over the past 10 years, but have quietly slipped into oblivion. Dr. Kenneth Oscar, the acting ASA RD&A in 1997, when referring to controlling life cycle costs said,

> We have tried several times in the past and failed. Pre-planned product improvement (P3I) came along four or five years ago, but we never really got the R&D money to do it. [Ref. 4]

How can a repeat of this be avoided? The recommendations developed through this research for institutionalizing MTS as a long-term approach to LCC management follow in the next section.

B. RECOMMENDATIONS

The recommendations for improvements to the MTS initiative can be structured into six primary categories: funding, incentives, metrics, conceptual approach, information management, and program management responsibilities to LCC reduction.

1. Funding

Reduce some of the restrictive barriers in LCC reduction initiatives established by the various colors of money. The goal of MTS, like other OSCR programs, is to reduce the LCC of a legacy system. The funding line this comes from should be transparent, or even non-existent, to a program office attempting to reduce LCC. The fact that it is not, and even compels some PM's not to institute a good LCC reduction initiative, should raise concerns at the highest levels within the Army. It simply results in inefficiencies when they can be ill afforded.

If some elements in the Army are opposed to the lifting of these funding barriers in their entirety, then a separate funding line supporting MTS initiatives should be

created. The amount of the funding should be flexible enough to support high MTS developmental costs on complex systems, such as aviation, that have the potential to generate the greatest ROI. Some of the cost savings/avoidance should then be reinvested in the MTS program to help fund other initiatives.

Ideally though, these LCC reduction funds should all be combined under one program that includes all the various LCC reduction programs, including MTS. Then good LCC reduction initiatives, such as Patriot Re-certification, continue to exist, and concerns about what the initiatives are termed are irrelevant. Only ROI and LCC savings/avoidance drive the selection process, not concerns over color of money.

Funding is critical for developmental systems as well. As the comment from Dr. Oscar above noted, without funding earmarked for R&D phases, the initiatives are doomed to failure. Programs can only implement what they can fund. Fund developmental initiatives to reduce LCC, and treat this up-front funding as an investment in future reduced costs.

2. Incentives

Incentives are used to motivate desired behavior. Therefore, since the desired behavior is a program reducing the LCC of a system, this should be incentivized. Arbitrarily reducing funding levels on subsequent years following a successful LCC reduction effort, or retaining all cost savings at higher echelons does little to motivate programs to reduce costs.

Consideration should be given to modeling O&S cost savings achievement incentives in a manner similar to the one in which a commercial contractor is rewarded for specific performance on an incentive-type contract. In other words, award a certain

percentage of the validated savings as additional funding for a program to reinvest in other MTS or LCC reduction efforts. That proportion should not be so high that it detracts from the reason that we are trying to reduce O&S costs in the first place – to enable increased amounts of funding for new systems.

Also, consider the use of special relationships with contractors to incentivize their participation in MTS initiatives. Long-term supplier relationships and PVS/CLS are excellent ways to motivate a contractor. Many major corporations, such as Toyota, implement relationships such as this to the benefit of all concerned parties. [Ref. 48]

3. Metrics

Metrics are critical for objectively measuring a program's progress. It is difficult to accomplish this in MTS with such poor metrics - You can't manage what you can't measure.

The use of the TDP metric, while well intentioned, is clearly meaningless. ROI or the number of the top cost/readiness drivers evaluated would be more appropriate. Since an integrated approach to LCC reduction is desired, metrics that measure a programs entire annual cost savings/avoidance, regardless of specific approach, as a percentage of their annual total LCC would be very appropriate. Programs that aggressively find methods to reduce LCC, yet improve reliability and performance would be classified as benchmark programs worthy of emulation. Numbers of TDP's reviewed and converted to performance specifications shows you are doing busy work, but possibly not much else.

4. Conceptual Approach

MTS should not be interpreted as an independent program. O&S cost reduction, or LCC management, should be viewed as an integrated program of approaches to cost

reduction, and managed as such. Unfortunately, challenges from funding restrictions – the color of money - serve to force these approaches to be viewed separately.

The Patriot OEP IPT appears to be an excellent integrated approach to LCC reduction. Their blurring of the line separating programs and funding lines resulted in good, common sense cost reduction initiatives like the re-certification effort. This type of integrated approach should be readily shared with other programs.

5. Information Management

The data collection system is very complex and disconnected. This makes the conversion of data to useable knowledge for programs trying to identify cost drivers, readiness drivers, or trends very difficult. Consequently, programs are often left making only educated guesses on exactly where to focus LCC reduction efforts.

Kathleen Boedeker, from the Aviation Program Executive Office, supports this argument. She suggested that a new database in development– Global Combat Service Support-Army (GCSS-A) – would correct this deficiency in the collection of data. The GCSS-A should integrate many of these existing sources and effectively convert the independently useless data into an integrated and useable source of knowledge. This new system should enable programs to better focus and validate MTS and/or LCC reduction efforts on problem areas with the potential to generate the greatest ROI. [Ref. 49]

All future information systems should be developed with a clear focus on providing integrated and relevant knowledge. The correct knowledge in itself will serve to increase ROI for LCC reduction initiatives.

6. Program Management responsibilities to LCC reduction

The PM will now be formally held responsible for LCC. Yet, the PM is provided inadequate resources and controls to execute an integrated LCC management program. First, management of spare parts is centralized at the IMMC. While IMMC's intentions might be good, their motivations are different. The PM has only an advisory role over a product he or she is being held responsible. Consideration should be given to placing the responsibility for spare parts back in program or project offices. Second, the complex funding arrangements imposed by the colors of money impede PM action. Remove some of these restrictions to encourage the PM to aggressively seek ways to reduce O&S costs. Third, management information tools, in the form of metrics and knowledge, are inadequate. All efforts in information technology should include the tools for enabling objective analysis of integrated information.

Given the impediments to executing an MTS or LCC reduction program, the success programs have is truly amazing. "We need to build on this success, continue to refine the legacy system, and enable the PM to be a partner in the Operations and Maintenance Army world expanding his or her efforts at reducing O&S costs." [Ref. 11, p. 12]

C. AREAS FOR FURTHER RESEARCH

1. Relationships Between OSCR Initiatives

Research the complex relationships of O&S cost reduction initiatives. Conduct an analysis to determine areas of duplication and/or funding limitations within these programs. Propose recommendations for any modifications or improvements to these initiatives to simplify and encourage their use.

2. Viability of PVS in Apache to Incentivize Reduction of LCC

Research the proposed Apache PVS contract and the background of other smaller scale prime vendor contracts. Conduct an analysis to clearly identify the benefits and challenges associated with implementing such a groundbreaking contract, especially as it relates to LCC and contractor incentives. Suggest methods to improve implementation of Apache PVS.

3. MTS Effectiveness on Various Programs

Conduct research on the impact of OSCR initiatives funding restrictions on the execution of an MTS strategy. Analyze which program types appear to benefit the most and why. Suggest recommendations to broaden and improve the use of MTS.

4. Program Manager Responsibility for the Total LCC

Investigate the formal and informal responsibilities of a program manager to total LCC management. Analyze the relationships, resources, and capabilities the program office has to leverage to control LCC through all acquisition phases of a program. Develop a set of lessons learned and make recommendations to improve program LCC management.

LIST OF REFERENCES

1. Ennis, Michael S., Evans, Thomas R., and Lyman, Kathleen M., *Modernization in Lean Times: Modifications and Upgrades*, Defense Systems Management College Press, 1995.

2. Office of the Under Secretary of Defense (Comptroller), *National Defense Budget Estimates for FY 2000*, March 1999.

3. Modernization Through Spares Homepage. Online. Internet. 12 April 1999. Available: http://www.amc.army.mil/amc/rda/milspec/mtshome.htm.

4. Gregory, Bill, "Grappling With Spares." *Armed Forces Journal International*, October 1997.

5. Bleicher, Harvey, "Interview with Paul J. Hoeper: Assistant Secretary of the Army for Acquisition, Logistics, and Technology and Army Acquisition Executive." *Army RD&A*, May-June 1999: 2-4.

6. Mohler, Lynn, "An Update on Modernization Through Spares." *Army RD&A*, March-April 1998: 22-25.

7. MIL-SPEC Reform Executive Summary. Online. Internet. 7 May 1999. Available: http://www.amc.army.mil/amc/rda/milspec/1executivesummary.html.

8. The BRTRC Institute, *Modernization Through Spares: Phase II Workbook*, Vol. 3, 1999.

9. Gansler, Jacques S., "The Revolution in Business Affairs – The Need to Act NOW." *PM Magazine*, September-October 1998: 30-33.

10. Gansler, Jacques S., "Statement of Dr. Jacques Gansler, Under Secretary of Defense (A&T)-designate before the Committee on Armed Services, United States Senate." *PM Magazine*, January-February 1998: 3-4.

11. Glasgow, Wesley L. and Yakovic, Joseph L., "Life Cycle Cost Drivers from the Program Manager's Perspective." *Army RD&A*, May-June 1998: 10-12.

12. U.S. Army Deputy Chief of Staff for Operations and Plans, *The United States Army Modernization Plan*, 1998.

13. Cuningham, Henry, "Falling Behind: Army Funding Draws Fire." *Fayetteville Observer-Times*, 19 May 1999.

14. Team C4IEWS, *Acquisition Reform Handbook*, 1998.

15. Gore, Albert, *Creating a Government That Works Better & Costs Less: The Report of the National Performance Review: Executive Summary*, Government Printing Office, 1993.

16. Kaminsky, Paul, *Update of the DOD 5000 Documents*, Executive Summary, 15 March 1996.

17. DSMC Defense Acquisition Acronyms and Terms 9th Edition. Online. Internet. November 1998. Available: http://web.deskbook.osd.mil.

18. Integrated Material Management Center - Aviation and Missile Command, *Modernization Through Spares Training*, Presentation, 9 May 1999.

19. Mullins, Terry L. and Pepper, Barry K., "Modernization Through Spares Implementation Process." *Army RD&A*, January-February 1999: 35-38.

20. Army Acquisition Reform Tools & Techniques Guidebook. Online. Internet. 29 April 1999. Available: http://procweb.sarda.army.mil/acqref/tools.htm.

21. Department of the Army, *Research, Development, and Acquisition, Army Acquisition Policy*, AR 70-1, 15 December 1997.

22. DSMC Acquisition Logistics Guide 3rd Edition. Online. Internet. December 1997. Available: http://web.deskbook.osd.mil.

23. *Acquisition Reform Impacts on Modernization Through Spares*, U.S. Army Missile Command Conference Presentation, 28 May 1997.

24. Manary, Joel M., "DSMC's CASA Model Still Going Strong." *PM Magazine*, January-February 1996: 37-40.

25. Goodson, Roger, *Modernization Through Spares: An Update*, Presentation, Total Cost of Ownership Reduction Conference, 27 July 1999.

26. *Fact Sheets*, Modernization Through Spares Conference, 16-18 November 1998.

27. Team Redstone Modernization Through Spares Strategy. Online. Internet. 29 April 1999. Available: http://loglab.redstone.army.mil/mtstoc.htm.

28. U.S. Army Office of the Deputy Chief of Staff for Research, Development, and Acquisition, *Weapon Systems 1999*, 1999.

29. Jane's Online. Online. Internet. 12 August 1998. Available: http://janesonline.com.

30. Nunn, Kelvin, *Patriot Recertification: Modernization Through Spares Strategy*, Presentation, 1998.

31. Patriot Project Office, *Patriot Sustainment Cost Management Annex*, Presentation, August 1998.

32. Nunn, Kelvin, *Solid State Data Storage For Patriot*, Information Paper, 1998.

33. United States General Accounting Office, *Apache Helicopter: Serious Logistical Support Problems Must Be Solved to Realize Combat Potential,* GAO/NSIAD-90-294, 28 September 1990.

34. Robbins, Marc L., and McIver, Douglas W., *Precision Guided Logistics*, RAND Arroyo Center, 1994.

35. Project Manager, Apache Helicopter Modernization Through Spares Implementation Strategy. Online. Internet. 27 April 1999. Available: http://www.peoavn.redstone.army.mil/aah/apache/ApacheWebpage/mts/mts.html.

36. Bahnen, Mike. Apache Project Office. Personal Interviews, July 1999.

37. Metzger, Bruce. Apache Procurement Contracting Officer. Personal Interviews, February 1999.

38. Hoeper, Paul J., *Army and Industry: Synergy for 21st Century Success*, Speech, AUSA West Coast Symposium, 25 June 1998.

39. Lund, John N., *Modernization Through PVS: Prime Vendor Support and the Apache Sensor System*, Paper, Modernization Through Spares Conference, 17 November 1998

40. Cahlink, George and Clark, Colin, "Waiver Will Allow Private Control of Apache Parts." *Defense News*, 16 November 1998: 30.

41. Modernization Through Spares: RAH-66 Comanche Strategy. Online. Internet. 15 August 1999. Available: http://www.peoavn.redstone.army.mil/rah/mtsrah66.htm.

42. Mcguire, Dennis. Comanche Logistics Management Specialist. Personal Interviews, July – September 1999.

43. Patriot Project Office, *Upgrade Projections*, Information Paper, April 1999.

44. Anderson, Dean. Staff Logistician, Air & Missile Defense PEO. Personal Interviews, July – August 1999.

45. "Roadblock for PVS?" *Helicopter News*, 12 February 1999.

46. Shannon, Brian, "Army Eyes Plan to End Longbow Buy at 500 in POM." *Defense Daily*, 5 March 1998.

47. Wright, Chuck. Apache Logistics Management Specialist. Personal Interviews, August – September 1999.

48. Womack, James P., Jones, Daniel T., Roos, Daniel, *The Machine that Changed the World*, Harper Perennial, 1990.

49. Boedeker, Kathleen. PEO Aviation Logistics Specialist. Personal Interviews, August – September 1999.

50. Adams, Ronald E., Charles, Keith, and Soo, Houng O., "Modernization Funding Trends: The Past and the Future." *Army RD&A,* March-April 1999: 39-43.

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center 2
   8725 John J. Kingman Rd., STE 0944
   Ft. Belvoir, VA 22060-6218

2. Dudley Knox Library 2
   Naval Postgraduate School
   411 Dyer Rd.
   Monterey, CA 93943-5101

3. Professor David M. Lamm (Code SM/Lt) 4
   Naval Postgraduate School
   Monterey, CA 93943-5103

4. LTC Brad Naegle (Code SM/Nb) 1
   Naval Postgraduate School
   Monterey, CA 93943-5103

5. Professor Keebom Kang (Code SM/Kk) 1
   Naval Postgraduate School
   Monterey, CA 93943-5103

6. CPT Todd Kros 2
   3020 NE 40th Street
   Fort Lauderdale, FL 33308